



US Army Corps  
of Engineers  
Savannah District

# **Federal Facilities in North Carolina and South Atlantic Division**

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**Solicitation Number**

**DACA21-03-R-0030**

**Indefinite Delivery, Multi-Task Construction and  
Design-Build Construction Contract**

**Volume II of III - Technical Provisions for Repair HVAC,  
Building 3300, Repair HVAC 2nd Floor Wing HQ, Repair  
"AFFF" Piping Buildings 4522, 4527 and 4538, and Repair Fire  
Suppression, Building 5015, Seymour Johnson AFB, NC  
August 2003**

**THIS SOLICITATION IS UNRESTRICTED PURSUANT TO THE  
"BUSINESS OPPORTUNITY DEVELOPMENT REFORM ACT OF 1988"  
(PUBLIC LAW 100-656)**

**CORPS OF ENGINEERS  
100 WEST OGLETHORPE AVENUE  
SAVANNAH, GEORGIA 31401-3640**

**SEYMOUR JOHNSON  
AIR FORCE BASE  
NORTH CAROLINA  
SPECIFICATIONS  
FOR**

**PROJECT TITLE: REPAIR HVAC-BUILDING 3300**

**PROJECT NO: VKAG 96-1000**

**PROJECT MANAGER: JEFFREY S. HOWARD**

**DATE: 26 JUNE 1997**



SEYMOUR JOHNSON AIR FORCE BASE

REPAIR HVAC - BUILDING 3300

VKAG 96-1000

SEYMOUR JOHNSON AFB, NORTH CAROLINA

HRA COMMISSION #140795.06



REPAIR HVAC - BUILDING 3300

(VKAG 96-1000)

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## SECTION - 01000 GENERAL

### PART 1. GENERAL

#### 1.1 SCOPE OF WORK

- 1.1.1 The work covered by this specification consists of furnishing all plant, labor, equipment and material, and performing all work in connection with VKAG 96-1000 Repair HVAC Building 3300 in strict accordance with these specifications and drawings and subject to the terms and conditions of this contract.

#### 2 LOCATION

The work is to be accomplished at Seymour Johnson Air Force Base, Goldsboro, North Carolina. This base is accessible by both public highway and railway.

#### 1 3 WORKWEEK

- 1.3.1 The contractor shall observe the same regular workweek being observed by the Seymour Johnson AFB Civil Engineering shop forces, which is 7:30 a.m. to 4:30 p.m, Monday through Friday, with Federal holidays excluded. Any deviation from this schedule will require 48 hours advance notice and approval of the Contracting Officer. (Note Paragraph 1.14.A.3).

#### 4 PRINCIPLE FEATURES

- 1.4.1 The work covered by this contract includes, but is not limited to the following:

A. BASE BID:

Removal of HVAC Units U-1, U-4, U-5, U-6, U-8, U-13, U-15, U-18. Provide new replacement units as shown on Construction Documents. Provide new electrical work as indicated to serve new units. In addition, provide outside air intake hoods on Units U-2, U-7, U-9, and U-14, to provide a minimum amount of outside air to each unit at all times. U-17 outdoor unit to be replaced. New supply from U-19 to provide outside air to U-17 space.

B. BID OPTION NO. 1:

Remove and replace Unit U-2 in lieu of providing intake air hood.

C      **BID OPTION NO. 2:**

Remove and replace Unit U-7 in lieu of providing intake hood.

D      **BID OPTION NO 3:**

Remove and replace Unit U-9 in lieu of providing intake hood.

E.     **BID OPTION NO. 4:**

Remove and replace Unit U-14 in lieu of providing intake hood.

5      **HAUL ROUTES**

5.1     The Contractor shall use the haul routes indicated on the plans.

6      **DISPOSITION OF NONSALVABLE MATERIALS**

6.1     All nonsalvable or unusable material shall be disposed of off base as directed by the Contracting Officer. All waste material generated by any work under this contract shall be handled, transported, stored and disposed of off base, by the Contractor, in accordance with all applicable federal, state, or local laws, ordinances, regulations, court orders, or other types of rules or rulings having the effect of law.

1.7     **DISPOSITION OF SALVAGEABLE MATERIALS**

The Contracting Officer's representative will identify all material and equipment to be salvaged. The Contractor shall obtain an AF Form 1348-1 from the Base Civil Engineering Material Control Section located in Building 3300 which requires an itemized listing of materials and equipment to be salvaged. After receiving this form, all salvable or reusable material will be delivered as directed by Contracting Officer.

1.8     **SUBMITTALS REQUIRED**

1.8.1   Required submittals are listed on AF Form 66

1.9 BASE CIVIL ENGINEERING WORK CLEARANCE REQUEST, AF FORM 103

1.9.1 The Contractor shall obtain AF Form 103, Base Civil Engineering Work Clearance Request, prior to work commencement from the Contract Management Section in Building 3300.

1.10 SAFETY

1.10.1 All safety requirements of the U.S. Army Corps of Engineers Safety Manual 385-1-1 dated October 1992 will be strictly adhered to as related to all work covered under these specifications.

1.10.2 The Contractor shall obtain a welding/cutting/brazing permit from the Technical Service Branch of the Fire Protection Flight-4CES/CEF Ext 5251 prior to start of such activities.

MATERIALS CONTAINING ASBESTOS

1 In the event the Contractor discovers materials suspected of containing asbestos that is not identified to be removed in the plans and specification, the Contractor shall notify the Contracting Officer. The Contractor's work shall proceed unless the materials suspected of containing asbestos are damaged or disturbed. Any suspected materials damaged or disturbed by the Contractor without permission from the Contracting Officer shall be removed by the Contractor at his expense IAW all applicable Federal, State, and local laws, or ordinances, regulations, court orders, or other types of rules or rulings having the effect of law.

1.12 LABELING OF STORAGE DRUMS

1.12.1 All 55 gallon or larger drums brought on base for use under this contract and containing new material or used for storage of waste materials or hazardous waste must be labeled with a Department of Transportation (DOT) Proper Shipping Name, DOT Hazardous Identification Number, the Contractor's name, a Contractor representative, and the Contractor's telephone number. Label lettering should have a minimum height of one half inch painted in white paint or other color that is in contrast with the color of the drum. The label should be sufficiently durable to equal or exceed the life (including storage and disposal) of the drum.

1.13 CONTRACTOR STORAGE TRAILER(S) AND BUILDING(S)

1.13.1 The Contractor shall place or paint a sign on all of his storage trailer(s) and building(s) used on this contract. At a minimum, the sign shall contain the name of the Contractor and a telephone number at which the Contractor can be reached. The trailer(s) and building(s) shall be complete with gates and/or doors which can be locked. Only material for this project shall be stored in the trailer(s) or building(s). The Contractor shall remove the storage trailer(s) or building(s) within 30 days after completion of the contract and prior to submitting his final invoice. The area around the storage trailer(s) and building(s) shall be kept clean. This includes the mowing of grass during the growing season. The lawn mower shall be supplied by the Contractor.

1.14 CONSTRAINTS (Contractor is responsible for providing protection against rain, etc., for the existing structures).

A GENERAL:

1. The Contractor shall cordon off site storage areas with orange safety fabric.
2. Contractor shall provide plastic or tarp covering to protect walls and floors during work. Ensure that exits and corridors are kept free of obstructions during work. Contractor shall remove debris from building daily. Contractor shall provide dust barriers between construction and non-construction areas.
3. Work that blocks exits shall be performed after normal operating hours of 6:30 A.M. until 6:00 P.M. or during weekends as approved by the Contracting Officer.
4. Work Performed After 30 September:  
Contractor shall provide temporary space heating to occupied areas at the Work sites to maintain areas at a minimum of 68 degrees F. The Contractor shall submit a plan for approval to provide temporary heat.

B. CONSTRUCTION:

All Base Bid work shall be completed in 120 calendar days. The building shall remain occupied during retrofit. Freeze protection shall be the responsibility of the contractor. All outages must be coordinated through the contracting officers representative. No power outages will be allowed. HVAC outages must be limited to 2 days per unit.

1.15 PHASING:

A. Phase I: The first 60 calendar days of the contract shall be limited to submittal approval and equipment ordering and delivery. Refer to AF Form 66 Submittal Codes for Due Dates. See AF Form 66, Schedule of Material Submittals, for list of submittals required. No on site work will be allowed during this phase of the contract.

B. Phase II

1 Base Bid:

The remaining 120 calendar days of the contract shall be utilized for on site work. All equipment submittals shall be approved prior to on site work.

2. Any bid options that are awarded shall be completed within the 120 day Base Bid construction period. No additional performance time will be given for completion of any option.

END OF SECTION - 01000

## SECTION 02051 - ASBESTOS REMOVAL, CLEANUP, AND DISPOSAL

### PART 1 GENERAL

#### GENERAL:

- 1.1.1 The term abate, as used in plans and specifications, shall mean to remove, cleanup, and dispose of asbestos containing materials (ACM). The work covered by this section includes the removal, cleanup, disposal of materials containing asbestos.

#### 2.1 DOCUMENTATION OF PERFORMANCE IN ASBESTOS REMOVAL:

- 1 The Contractor shall furnish documentation of successful performance in asbestos removal. This documentation will include names and addresses of purchasers of services and location of work performed.
- 2.1.2 The Contractor shall have at all times in his possession at his office (one copy) and in view at the job site (one copy) OSHA Regulation 29 CFR 1926.58, Asbestos and Environmental Protection Agency 40 CFR, Part 61, Subpart B: National Emission Standard for Asbestos, Asbestos Stripping Work Practices, and Disposal of Asbestos Waste; N.C. General Statute 130A, Article 19, Asbestos Hazard Management.

#### REGULATORY REQUIREMENTS:

- 3.1.1 All asbestos removal, cleanup, and disposal shall be made in accordance with:
- 3.1.2 N.C. General Statute 130A, Article 19 and OSHA Regulation 1926.58 - Asbestos, permissible exposure limits for asbestos shall apply to all air samples:
- |         |             |                |
|---------|-------------|----------------|
| 3.1.2.1 | Amosite     | 0.01 fibers/cc |
| 3.1.2.2 | Chrysotile  | 0.01 fibers/cc |
| 3.1.2.3 | Crocidolite | 0.01 fibers/cc |
| 3.1.2.4 | All others  | 0.01 fibers/cc |
- 3.1.2 EPA 40 CFR, Part 61, Subpart B - National Emission Standard for Asbestos, Asbestos Stripping, Stripping Work Practice, and Disposal of Asbestos Waste.
- 3.1.3 Other State and Local Agency Requirements.

4.1        **SUBMITTALS:**

- 4.1.1       Pre-Removal Plan: Submit a detailed plan of the work procedures to be used in the removal and demolition of materials containing asbestos. The pre-removal plans must be approved and signed by an N.C. State accredited Asbestos Abatement Project Designer. Such plan shall include location of asbestos control areas, change rooms, layout of change rooms, interface of trades involved in the construction, sequencing of asbestos related work, disposal plan, type of wetting agent and asbestos sealer to be used, air monitoring, and a detailed description of the method to be employed in order to control pollution. Provide copies of all notifications sent to agencies. This plan must be approved prior to the start of any asbestos work. Include North Carolina Asbestos Accreditation Certificates for each worker and Accredited Supervisor and Asbestos Removal Permits/Notifications when removal quantities required by N.C. Statute 130A, Article 19.
- 4.1.2       Submit personnel and space air monitoring and final clearance reports.
- 4.1.3       Training: Submit certificates signed by each employee that the employee has received current accredited training within 14 months of scheduled removal work in the proper handling of materials that contain asbestos; understands the health implications and risks involved, including the illness possible from exposure to airborne asbestos fibers; understands the use and limits of the respiratory equipment to be used; and understands the results of monitoring of airborne quantities of asbestos as related to health and respiratory equipment.
- 4.1.4       Return manifest signed by company or landfill accepting custody of asbestos waste within 24 hours. Minimum information on the manifest shall include; date of disposal, quantity, sources of asbestos waste type of insulation (pipe, duct, etc.), name of certified/licensed asbestos removal contractor.

5.1        **REMOVAL, CLEANUP, AND PREPARATION:**

- 5.1.1       The Contractor shall have proper dress and equipment for all personnel. The Contractor shall provide proper decontamination facilities. The method of asbestos removal shall be conducted as required by regulation. Work areas shall be decontaminated prior to resuming other activities.

6.1        PHASING AND SCOPE:

6.1.1      Phasing of asbestos removal will be coordinated by the general Contractor and approved by the Contracting Officer.

7.1        ASBESTOS TEST RESULTS:

7.1.1      Asbestos Test Results are attached for information purposes only and cannot be guaranteed by the Government and Architect.

7.1.2      Asbestos test results determined by Seymour Johnson AFB, 4CES, CEOIB are as follows:

7.1.2.1    Visual inspection, data base inquiry and bulk sampling were accomplished 14 Apr 97 by abatement shop personnel. Eighteen samples were taken in support of this work request. Dark brown ceiling tile mastic was positive with 3% chrysotile, sheetrock joint material on the walls and ceiling were negative, no asbestos found. Roofing tar was negative, no asbestos found. Samples were taken in Room 69 Drafting, Room 19 above the drop ceiling, Outside Rooms 104 and 105 and roofing tar samples from the bottom of the penthouse above Engineering.

7.1.2.1.2 The Facility Report is bound into the specifications at the end of this section.

END OF SECTION - 02051

# FACILITY REPORT

28-Apr-97

3300

SAMPLE  
NO.

	CALL #	W/O#	DATE TAKEN	TAKEN BY	GIVEN TO	RESULTS
001	0000	N/A	3/4/87		BIO-ENV	
	MISCELLANEOUS		INSULATION			N/D
	ABOVE CEILING IN DEM OFFICES					
002	0000	N/A	3/4/87		BIO-ENV	
	MISCELLANEOUS		CEILING BOARD			N/D
	DEM OFFICE					
003	0000	N/A	3/6/87		BIO-ENV	
	DUCKWORK					N/D
	VENTILATION SYSTEM COMPUTER ROOM					
004	0000	N/A	3/6/87		BIO-ENV	
	PIPE INSULATION		STEAMLINE			N/D
	COMPUTER ROOM					
005	0000	N/A	3/4/88		BIO-ENV	
	PIPE INSULATION					15-30% CHRYS. 15-30% AMOSIT
006	0000	N/A	5/12/92		BIO-ENV	
	NN		CELLULOSE			N/D
007	0000	N/A	5/12/92		BIO-ENV	
	NN		WOOL			N/D
008						

CALL #	W/O#	DATE TA	TAKEN BY	GIVEN TO	RESULTS
0002	R7636	1/15/93		CAR-ENV	
MISCELLANEOUS			ROOF MATERIAL		N/D
MISCELLANEOUS			BLACK FIBROUS STICKY		N/D
009					
0002	R7636	1/15/93		CAR-ENV	
MISCELLANEOUS			ROOF MATERIAL		N/D
MISCELLANEOUS			BLACK FIBROUS STICKY		N/D
010					
0002	R7636	1/15/93		CAR-ENV	
MISCELLANEOUS			ROOF MATERIAL		N/D
MISCELLANEOUS			BLACK FIBROUS STICKY		N/D
011					
0002	R7636	1/15/93		CAR-ENV	
MISCELLANEOUS			ROOF MATERIAL		N/D
MISCELLANEOUS			BLACK FIBROUS STICKY		N/D
012					
0002	R7636	1/15/93		CAR-ENV	
MISCELLANEOUS			ROOF MATERIAL		N/D
MISCELLANEOUS			BLACK/BROWN FIBROUS CHUNK		N/D
013					
0002	R7636	1/15/93		CAR-ENV	
MISCELLANEOUS			ROOF MATERIAL		N/D
MISCELLANEOUS			BLACK FIBROUS STICKY		N/D
MISCELLANEOUS			BEIGE FIBROUS FRIABLE		N/D
014					
0002	R7636	1/15/93		CAR-ENV	
MISCELLANEOUS			ROOF MATERIAL		N/D
MISCELLANEOUS			BLACK FIBROUS STICKY		N/D
MISCELLANEOUS			BEIGE FIBROUS FRIABLE		N/D
015					
0002	R7636	1/15/93		CAR-ENV	
MISCELLANEOUS			TRANSITE		40% CHRYS.
NN			GRAY FIBROUS NON FRIABLE		
016					

CALL #	W/O#	DATE TA	N	TAKEN BY	GIVEN TO	RESULTS
0002	R7636	1/15/93			CAR-ENV	
MISCELLANEOUS				TRANSITE		40% CHRYS.
NN				GRAY FIBROUS NON FRIABLE		
<hr/>						
017						
0000	R9344	2/23/93			BIO-ENV	
CARPET						N/D
<hr/>						
018						
0005		2/9/93	WTC		CAR-ENV	
CARPET			W/MASTIC			N/D
MISCELLANEOUS			LIGHT FLOOR TILE			N/D
MISCELLANEOUS			MASTIC			5% CHRYS
<hr/>						
019						
0006		2/17/93	KM		CAR-ENV	
9X9 LIGHT FLOOR TILE						N/D
MISCELLANEOUS			LIGHT FLOOR TILE SIZE N/A			N/D
BLACK MASTIC						N/D
<hr/>						
020						
0006		2/17/93	KM		CAR-ENV	
9X9 LIGHT FLOOR TILE						N/D
BLACK MASTIC						N/D
MISCELLANEOUS			WHITE POWDER SUBSTANCE			NO ANALYSIS
<hr/>						
021						
0022	44999	8/4/93	PC		CAR-ENV	
12X12 LIGHT FLOOR TILE			BROWN			ND
BLACK MASTIC						5% CHRYS.
ROOM #49 (ZONE 2)						
<hr/>						
022						
0022	44999	8/4/93	PC		CAR-ENV	
12X12 LIGHT FLOOR TILE			BROWN			ND
BLACK MASTIC						5% CHRYS.
ROOM #50 (ZONE 2)						
<hr/>						
023						
0022	44999	8/5/93	LM		CAR-ENV	
CARPET			BROWNISH/RED			ND
TAN MASTIC						ND
HALLWAY #3						
<hr/>						
024						

	CALL #	W/O#	DATE T/P	N	TAKEN BY	GIVEN TO	RESULTS
022	0022	44999	8/5/93	LM		CAR-ENV	
	CARPET			BROWNISH/RED			ND
	TAN MASTIC						ND
	HALLWAY #1						
025	0022	44999	8/5/93	LM		CAR-ENV	
	CARPET			BROWNISH/RED			ND
	TAN MASTIC						ND
	HALLWAY #2						
026	0034	00156	11/19/93	LM		CAR-ENV	
	WALL JOINT COMPOUND						ND
	ORDERLY ROOM						
027	0034	00156	11/19/93	LM		CAR-ENV	
	WALL JOINT COMPOUND						ND
	ORDERLY ROOM						
028	0038	00156	1/11/94	LM		CAR-ENV	
	12X12 LIGHT FLOOR TILE			WHITE			ND
	BLACK MASTIC						ND
	HALL 1						
029	0038	00156	1/11/94	LM		CAR-ENV	
	12X12 LIGHT FLOOR TILE			GREY			ND
	BLACK MASTIC						5% CHRYS.
	HALL 1						
030	0038	00156	1/11/94	LM		CAR-ENV	
	9X9 LIGHT FLOOR TILE			TAN			5% CHRYS
	BLACK MASTIC						ND
	HALL 1						
031	0038	00156	1/11/94	LM		CAR-ENV	
	12X12 DARK FLOOR TILE			GREY			5% CHRYS.
	BLACK MASTIC						
	HALL 1						
032							

CALL #	W/O#	DATE TAKEN	TAKEN BY	GIVEN TO	RESULTS
0038	00156	1/11/94	LM	CAR-ENV	
12X12 LIGHT FLOOR TILE		WHITE			ND
TAN MASTIC					ND
HALL 1					
033					
0038	00156	1/11/94	LM	CAR-ENV	
9x9 DARK FLOOR TILE		GREEN			ND
BLACK MASTIC					5% CHRYS.
TAN MASTIC					ND
HALL 1					
034					
0038	00156	1/11/94	LM	CAR-ENV	
9x9 DARK FLOOR TILE		GREEN			ND
BLACK MASTIC					5% CHRYS.
TAN MASTIC					ND
HALL 1					
035					
0038	00156	1/11/94	LM	CAR-ENV	
9x9 DARK FLOOR TILE		BLACK			5% CHRYS.
BLACK MASTIC					ND
HALL 1					
036					
0038	00156	1/11/94	LM	CAR-ENV	
9x9 DARK FLOOR TILE		BLACK			5% CHRYS.
BLACK MASTIC					ND
HALL 1					
037					
0038	00156	1/11/94	LM	CAR-ENV	
9X9 LIGHT FLOOR TILE		TAN			ND
BLACK MASTIC					5% CHRYS.
HALL 1					
038					
0042	00156	3/16/94	ES	CAR-ENV	
MISCELLANEOUS		WHITE SPRAY-ON MATERIAL			N/D
ROOM 69					
039					
0042	00156	3/16/94	ES	CAR-ENV	
MISCELLANEOUS		WHITE SPRAY-ON MATERIAL			N/D
ROOM 69					
040					

CALL #	W/O#	DATE T/	N	TAKEN BY	GIVEN TO	RESULTS
0042	00156	3/16/94	ES	CAR-ENV		
MISCELLANEOUS			WHITE SPRAY-ON MATERIAL			N/D
ROOM 69						
041						
0042	00156	3/16/94	ES	CAR-ENV		
MISCELLANEOUS			DARK BROWN MASTIC			N/D
ROOM 68						
042						
0042	00156	3/17/94	ES	CAR-ENV		
MISCELLANEOUS			DARK BROWN MASTIC			N/D
ROOM 68						
043						
0042	00156	3/22/94	ES	CAR-ENV		
WALL JOINT COMPOUND						N/D
ROOM 116						
044						
0042	00156	3/22/94	ES	CAR-ENV		
WALL JOINT COMPOUND						N/D
ROOM 116						
045						
0042	00156	3/22/94	ES	CAR-ENV		
WALL JOINT COMPOUND						N/D
ROOM 113						
046						
0042	00156	3/22/94	ES	CAR-ENV		
WALL JOINT COMPOUND						N/D
ROOM 113						
047						
0042	00156	3/22/94	ES	CAR-ENV		
WALL JOINT COMPOUND						N/D
ROOM 116						
048						

CALL #	W/O#	DATE T/	EN	TAKEN BY	GIVEN TO	RESULTS
0042	00156	3/22/94	ES	CAR-ENV		N/D
WALL JOINT COMPOUND						

ROOM 116

049

0042	U1373	3/23/94	PC	CAR-ENV	
CARPET			BLUE		N/D
TAN MASTIC					N/D

ROOM 116

050

0042	U1373	3/23/94	PC	CAR-ENV	
CARPET			BLUE		N/D
TAN MASTIC					N/D

ROOM 116

051

0050	00156	6/28/94	CM	CAR-ENV	
MISC OR SAFE INSULATION			SAFE INSULATION		20% CHRYSOTI

ZONE 1

052

0050	00156	6/28/94	CM	CAR-ENV	
MISC OR SAFE INSULATION			SAFE INSULATION		25% CHRYSOTI

ZONE 1

053

0050	00156	6/28/94	CM	CAR-ENV	
MISC OR SAFE INSULATION			SAFE INSULATION		25% CHRYSOTI

ZONE 1

054

0052	00156	8/22/94	PC	CAR-ENV	
LINOLEUM			LINOLEUM GRN. BLACK MAST.		20% CHRYSOTI
			BLACK MASTIC		20% CHRYSOTII

ASBESTOS SHOP

055

0053		10/3/94	DC	CAR-ENV	
MISC OR SAFE INSULATION			BLK CLUTCH DUST		N/D

MULCHING MACHINE

056

CALL #	W/O#	DATE TAKEN	TAKEN BY	GIVEN TO	RESULTS
0053		10/3/94	DC	CAR-ENV	
MISC OR SAFE INSULATION		BLK CLUTCH PART			N/D
MULCHING MACHINE					
057					
0053		10/3/94	DC	CAR-ENV	
MISC OR SAFE INSULATION		BLK CLUTCH PART			N/D
MULCHING MACHINE					
058					
0053		10/4/94	DRO	CAR-ENV	
12X12 ACOUSTICAL TILE		12X12 TILE W/WHITE PAINT			N/D
059					
0057		12/7/94	DC	CAR-ENV	
2X2 DROP CEILING TILE					N/D
NN		POC DAN CONNOLLY			
060					
0057		12/7/94	DC	CAR-ENV	
W3					N/D
NN		POC DAN CONNOLLY			
061					
0057		12/7/94	DC	CAR-ENV	
PLASTER					N/D
NN		POC DAN CONNOLLY			
062					
0057		12/7/94	DC	CAR-ENV	
PLASTER					N/D
NN		POC DAN CONNOLLY			
063					
0060		1/9/95	DC	CAR-ENV	
WALL JOINT COMPOUND		MUD WITH PAPER			N/D
ON THE WALL OF ROOM 95. UPPER CORNER JUST BELOW DROP CEILING					
064					

CALL #	W/O#	DATE T/	N	TAKEN BY	GIVEN TO	RESULTS
0060		1/9/95	DC		CAR-ENV	
WALL JOINT COMPOUND			MUD WITH PAPER			N/D
ROOM #96 WALL JUST ABOVE DROP CEILING NEXT TO COLUMN						
065						
0060		1/9/95	DC		CAR-ENV	
12X12 DARK FLOOR TILE			BLACK AND TAN			5%CHRYSTILE
NN			YELLOW CARPET MASTIC			AND BLACK MA
NN			GREEN TILE MASTIC			
BETWEEN ROOMS 96 & 97 IN HALLWAY						
066						
0060		1/9/95	DC		CAR-ENV	
12X12 LIGHT FLOOR TILE			LIGHT TAN			N/D
BLACK MASTIC						2% CHRYSTIL
NN			YELLOW CARPET MASTIC			N/D
HALLWAY BETWEEN ROOMS 96 & 97						
067						
0060		1/25/95	DC		CAR-ENV	
NN			TEXTURE CEILING MATERIAL			N/D
NN			POC DAN CONNOLLY			
068						
0060			DC		CAR-ENV	
NN			TEXTURED CEILING MATERIAL			N/D
NN			POC DAN CONNOLLY			
069						
0074	00156	7/12/95	DC		CAR-ENV	
12X12 LIGHT FLOOR TILE			MISC. TILE WHITE/STRIPED			ND
FROM DARE COUNTY						
070						
0074	00156	6/26/95	DC		CAR-ENV	
9X9 LIGHT FLOOR TILE			LT. BROWN FLOOR TILE			ND
TAN MASTIC			TAN MASTIC (UNDERNEATH)			<1% CHRYS
BLACK MASTIC			BLACK MASTIC			5%CHRY
MISC. TILE						
071						
0086	00156	12/6/95	DC		CR-ENV	
LINOLEUM			PROJECT			nd
072						

CALL #	W/O#	DATE T/	EN	TAKEN BY	GIVEN TO	RESULTS
0086	00156	12/6/95	DC	CAR-ENV		25% chry
LINOLEUM			PROJECT			
<hr/>						
073						
0091	00156	2/6/96	DC	CAR-ENV		
LINOLEUM			1ST LAY LINOLIUM TAN			ND (TOT 25% C
LINOLEUM			2ND LAY LINOLIUM GREY			65%CHRY
KITCHEN FLOOR						
<hr/>						
074						
0091	00156	2/6/96	DC	CAR-ENV		
LINOLEUM			1ST LAY LINOLIUM TAN			ND (TOT 25% C
LINOLEUM			2ND LAY LINOLIUM GREY			65%CHRY
KITCHEN FLOOR						
<hr/>						
075						
0096	X2095	2/29/96	LC	CAR-ENV		
12X12 LIGHT FLOOR TILE			1stLay.12X12orangeFl.Tile			ND
MISCELLANEOUS			2ndlay.leveling coumpound			2%CHRY,2%TRE
BLACK MASTIC			3rdLay.black mastic			15%CHRY
HALLWAY 1 (See X75 for additional layers)						
<hr/>						
076						
0096	X2095	2/29/96	LC	CAR-ENV		
TAN MASTIC			1STLAY.OFF WHITE MASTIC			ND
12X12 LIGHT FLOOR TILE			2NDLAY.BEIGE FL TILE			10%CHRY
BLACK MASTIC			3RDLAY. BLACK MASTIC			ND (TOT.8%)
HALLWAY 1						
<hr/>						
077						
0096	X2095	2/29/96	LC	CAR-ENV		
TAN MASTIC			1STLAY.OFFWHITE MASTIC			ND
12X12 LIGHT FLOOR TILE			2NDLAY.BEIGE FL TILE			10%CHRY
BLACK MASTIC			3RDLAY.BLACK MASTIC			ND (TOT.8%)
HALLWAY 1						
<hr/>						
078						
0098	X0156	5/21/96	DT	CAR-ENV		
CEILING PLASTER			PLASTER CEILING MATERIAL			ND
INSIDE LEFT CORNER OF RM.60						
<hr/>						
079						
0098	00156	5/17/96	DT	CAR-ENV		
CEILING PLASTER			PLASTER CEILING MATERIAL			ND
LEFT CORNER REAR OF ROOM 60						
<hr/>						
080						

CALL #	W/O#	DATE T/	TN	TAKEN BY	GIVEN TO	RESULTS
0098	00156	5/17/96	DT	CAR-ENV		ND
CEILING PLASTER		PLASTER CEILING MATERIAL				

RIGHT SIDE OF HALLWAY NEXT TO RM.57

081

0098	OO156	5/21/96	DT	CAR-ENV	
CEILING PLASTER		PLASTER CEILING MATERIAL			
					ND

HALLWAY 1 NEXT TO REFRIGERATOR

082

0098	00156	5/21/96	DT	CAR-ENV	
WALL JOINT COMPOUND		SHEETROCK MUDJOINT			
					ND

RM.62 BEHIND DOOR (WALL)

083

0098	00156	5/21/96	DT	CAR-ENV	
WALL JOINT COMPOUND		SHEETROCK MUDJOINT			
					ND

RM.59 STRAIGHT AHEAD FROM ENT

084

0098	X4467	5/21/96	DT	CAR-ENV	
SHEETROCK		CORE SAMPLE (SHEETROCK)			
					ND

RM.57 RIGHT SIDE OF DOOR FRAME

085

0098	00156	5/21/96	DT	CAR-ENV	
SHEETROCK		CORE SAMPLE (SHEETROCK)			
					ND

RM.60

086

0098	00156	5/21/96	DT	CAR-ENV	
2X2 DROP CEILING TILE		2X2 DROP CEILING TILE			
					ND

ROOM 57

087

0098	00156	5/21/96	DT	CAR-ENV	
2X2 DROP CEILING TILE		2X2 DROP CEILING TILE			
					ND

ROOM 56

088

CALL #	W/O#	DATE T/	EN	TAKEN BY	GIVEN TO	RESULTS
0104	X7323	8/22/96	JS			
12X12 LIGHT FLOOR TILE			12X12 FLOOR TILE			3% CHRYS
BLACK MASTIC			BLACK MASTIC			<1%
TAN MASTIC			TAN MASTICK			<1%
RM 79						
089						
0104	X7573	8/29/96	JS	CAR-ENV		
12X12 DARK FLOOR TILE			FLOOR TILE 12X12			3% CHRYS
BLACK MASTIC			BLACK MASTIC			<1%
TAN MASTIC			TAN MASTIC			<1%
RM79						
090						
0104	X7573	8/29/96	DC	CAR-ENV		
12X12 LIGHT FLOOR TILE			12X12 FLOOR TILE TAN			5% CHRYS
BLACK MASTIC			BLACK TAN MASTIC			<1%
RM79						
091						
0104	X7573	8/29/96	DC	CAR-ENV		
12X12 LIGHT FLOOR TILE			12X12 FLOOR TILE TAN			5% CHRYS
BLACK MASTIC			BLACK MASTIC			<1%
RM79						
092						
0104	X7573	8/29/96	DC	CAR-ENV		
12X12 LIGHT FLOOR TILE			12X12 FLOOR TILE TAN			5% CHRYS
BLACK MASTIC			BLACK MASTIC			<1% CHRYS
RM79						
093						
	Y2511	4/14/97	DT			
			DRK. BROWN MASTIC, CEILING ABOVE DROP CEILING			3 % CHRY
	RM. 69 DRAFTING					
094						
	Y2511	4/14/97	DT			
			DRK. BROWN CEILING TILE MASTIC			3% CHRY
	RM. 69, DRAFTING (ABOVE DROP)					
095						
	Y2511	4/14/97	DT			
			DRK. BROWN CEILING TILE MASTIC			3% CHRY
	RM. 69 DRAFTING (ABOVE DROP)					
096						

<u>CALL #</u>	<u>W/O#</u>	<u>DATE T/</u>	<u>IN</u>	<u>TAKEN BY</u>	<u>GIVEN TO</u>	<u>RESULTS</u>
0121	Y2511	4/14/97	DT			ND
			MUD JOINT			
RM. 69 (ABOVE DROP)						
097						
0121	Y2511	4/14/97	DT			ND
			MUDJOINT			
RM. 69 (ABOVE DROP)						
098						
	Y2511	4/14/97	DT			ND
			MUDJOINT			
RM. 69 (ABOVE DROP)						
099						
	Y251	4/14/97	DT			ND
			CEILING MUDJOINT			
RM. 19 ABOVE DROP						
100						
0121	Y2511	4/14/97	DT			ND
			CEILING MUDJOINT			
RM. 19 ABOVE DROP						
101						
	Y2511	4/14/97	DT			ND
			CEILING MUDJOINT			
RM. 19 ABOVE DROP						
102						
	Y2511	4/14/97	DT			ND
			WALL MUDJOINT			
OUTSIDE RM. 104 & 105						
103						
	Y2511	4/14/97	DT			ND
			WALL MUDJOINT			
OUTSIDE RM. 104 & 105						
104						

CALL #	W/O#	DATE T/	IN	TAKEN BY	GIVEN TO	RESULTS
0121	Y2511	4/14/97	DT			ND
				NALL MUDJOINT		

OUTSIDE RM. 104& 105

105

Y2511 4/14/97 DT  
ROOFING TAR ND

BOTTOM OF PENTHOUSE ABOVE ENGINEERING

106

Y2511 4/14/97 DT  
ROOFING TAR ND

BOTTOM OF PENTHOUSE ABOVE ENGINEERING

107

Y2511 4/14/97 DT  
ROOFING TAR ND

BOTTOM OF PENTHOUSE ABOVE ENGINEERING

108

Y2511 4/14/97 DT  
ROOFING TAR ND

SURFACE OF ROOF

109

0121 Y2511 4/14/97 DT  
ROOFING TAR ND

SURFACE OF ROOF

110

0121 Y2511 4/14/97 DT  
ROOFING TAR ND

SURFACE OF ROOF

A01

0031 T6975 10/20/93 PC CAR-ENV  
ASBESTOS AIR AREA SAMPLE  
NN TIME: 1300-1600  
NN PUMP #07365 FLOW 8.0 .01 F/CC

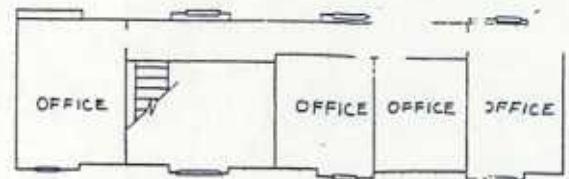
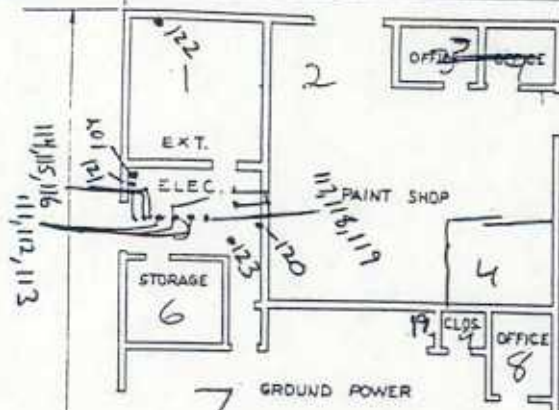
A02

CALL #	W/O#	DATE T/	IN	TAKEN BY	GIVEN TO	RESULTS
0031	T6975	10/20/93	PC		CAR-ENV	
	ASBESTOS AIR		AREA SAMPLE			
	NN		TIME: 1300-1600			
	NN		PUMP #07365			< .01 F/CC
	MEN'S BATHROOM					
A03						
0042	45149	3/20/94	PC		CAR-ENV	
	ASBESTOS AIR		AREA SAMPLE			
	NN		TIME: 0500-1030			< .01 F/CC
	NN		PUMP#07357 FLOW 4.0			
	OUTSIDE CONTAINMENT					
A04						
0042	45149	3/19/94	PC		CAR-ENV	
	ASBESTOS AIR		AREA SAMPLE			
	NN		TIME: 0500-1030			< .01 F/CC
	NN		PUMP#07365 FLOW 4.0			
	EXHAUST CUSTOMER SERVICE					
A05						
0042	45149	3/19/94	PC		CAR-ENV	
	ASBESTOS AIR		AREA SAMPLE			
	NN		TIME: 0500-1030			BROKEN
	NN		PUMP#0689 FLOW 4.0			
	OUTSIDE CONTAINMENT					
A06						
0042	45149	3/19/94	PC		CAR-ENV	
	ASBESTOS AIR		AREA SAMPLE			
	NN		TIME: 0530-1030			< .01 F/CC
	NN		PUMP#0689 FLOW 4.0			
	INSIDE CONTAINMENT					
A07						
0042	45149	3/20/94	PC		CAR-ENV	
	ASBESTOS AIR		AREA SAMPLE			
	NN		TIME: 0730-1200			< .01 F/CC
	NN		PUMP#0689 FLOW 4.0			
	OUTSIDE CONTAINMENT					
A08						
0042	45149	3/20/94	PC		CAR-ENV	
	ASBESTOS AIR		AREA SAMPLE			
	NN		TIME: 0730-1200			< .01 F/CC
	NN		PUMP#0689 FLOW 4.0			
	OUTSIDE CONTAINMENT					
A09						
0042	45149	3/20/94	PC		CAR-ENV	
	ASBESTOS AIR		AREA SAMPLE			
	NN		TIME: 0730-1200			< .01 F/CC
	NN		PUMP#07357 FLOW 4.0			
	EXHAUST BACK OF C.E.					
A10						

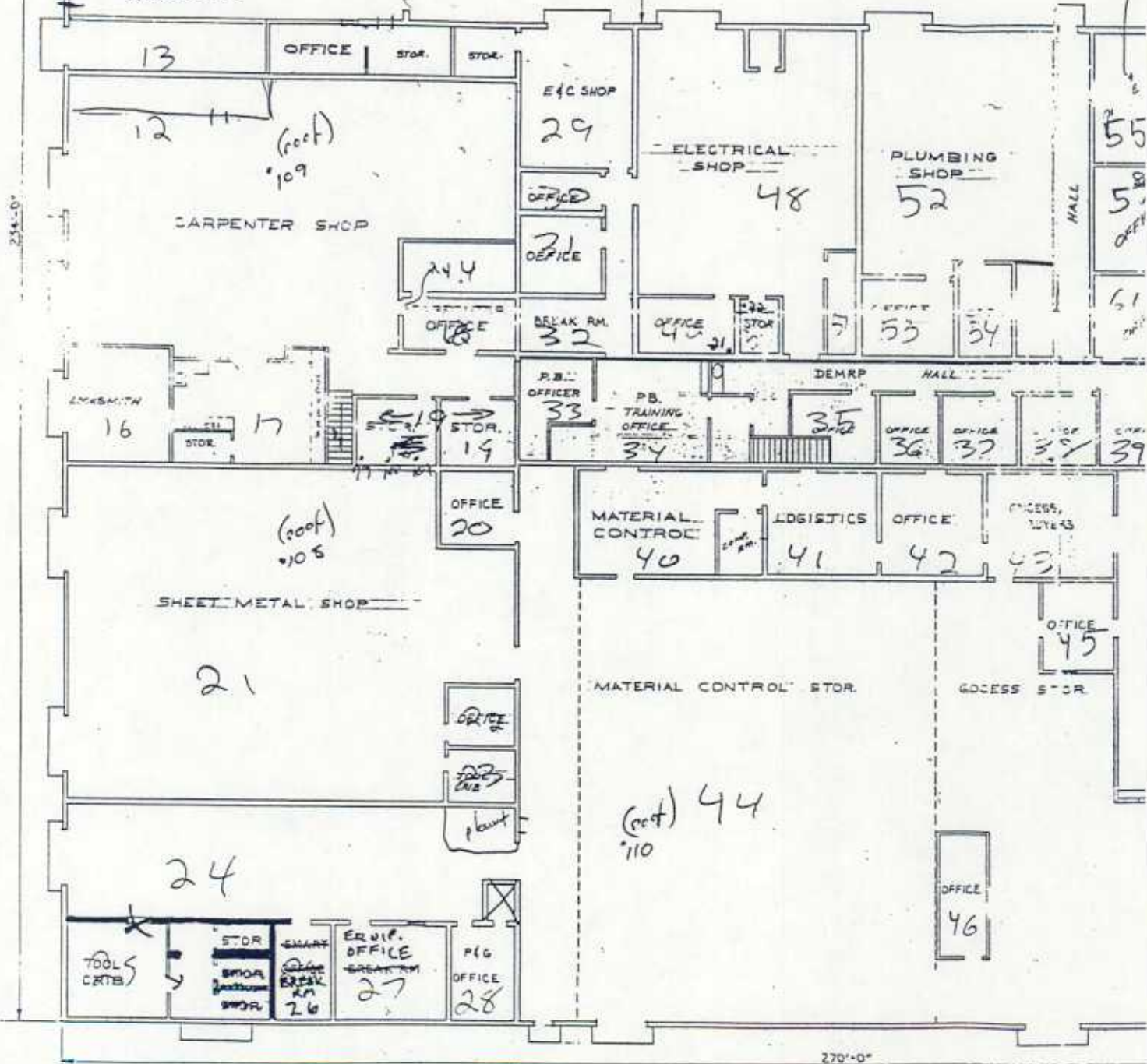
<u>CALL #</u>	<u>W/O#</u>	<u>DATE T' EN</u>	<u>TAKEN BY</u>	<u>GIVEN TO</u>	<u>RESULTS</u>
0042	45149	3/20/94	PC	CAR-ENV	
ASBESTOS AIR			AREA SAMPLE		< .01 F/CC
NN			TIME: 0730-1200		
NN			PUMP#0689 FLOW 4.0		
INSIDE CONTAINMENT					
<b>X75</b>					
0096	X2095	2/29/96	LC	CAR-ENV	
12X12 LIGHT FLOOR TILE			4THLAY.12X12BEIGEFLTILE		10%CHRY
BLACK MASTIC			5THLAY.BLACK MASTIC		ND (TOT.5%CRY
HALLWAY 1 (CONTINUATION OF SAMPLE # 075)					

54'-6"

142'-6"



DEE  
SECOND FLOOR PLAN



270'-0"



## SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS

### PART 1. GENERAL

#### 1.1 SUMMARY:

This Section includes the following basic mechanical materials and methods to complement other Division 15 Sections.

- 1 Equipment nameplate data requirements
- 1.2 Field-fabricated metal and wood equipment supports.
- 1.3 Installation requirements common to equipment specification Sections.
- 1.1.4 Mechanical demolition.
- 1.1.5 Cutting and patching.
- 1.1.6 Touchup painting and finishing.

#### 2 DEFINITIONS:

- 2.1 Pipe, pipe fittings, and piping include tube, tube fittings, and tubing.
- 2.2 Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- 1.2.3 Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- 1.2.4 Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- 1.2.5 Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

Concealed Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

**SUBMITTALS:**

- 1.3.1 General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
- 1.3.2 Shop drawings detailing fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.

**QUALITY ASSURANCE:**

- 1 Qualify welding processes and operators for structural steel according to AWS D1.1 "Structural Welding Code-Steel."
- 1.4.1.1 Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.
- 1.4.2 ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.
- 3 Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

**SEQUENCING AND SCHEDULING:**

- 1.5.1 Coordinate mechanical equipment installation with other building components.
- 1.5.2 Arrange for chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

- 1.5.3 Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work.
- 1.5.4 Coordinate connection of electrical services.
- 1.5.5 Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces.

## PART 2. PRODUCTS

- 2.1 IDENTIFYING DEVICES AND LABELS:
  - 2.1.1 Plastic Equipment Markers: Laminated-plastic, color-coded equipment markers. Conform to following color code:
    - 2.1.1.1 Green: Cooling equipment and components.
    - 2.1.1.2 Yellow: Heating equipment and components.
    - 2.1.1.3 Yellow/Green: Combination cooling and heating equipment and components.
    - 2.1.1.4 Blue: Equipment and components that do not meet any of the above criteria.
    - 2.1.1.5 For hazardous equipment, use colors and designs recommended by ASME A13.1.
    - 2.1.1.6 Nomenclature: Include following, matching terminology on schedules as closely as possible:
      - 2.1.1.6.1 Name and plan number
      - 2.1.1.6.2 Equipment service.
      - 2.1.1.6.3 Design capacity.
      - 2.1.1.6.4 Other design parameters such as pressure drop, entering and leaving conditions, and rpm.
    - 2.1.1.7 Size: Approximately 2-1/2 by 4 inches (65 by 100 mm) for control devices, dampers, and valves; and 4-1/2 by 6 inches (115 by 150 mm) for equipment.

- 2.1.2 Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, lettering, and wording indicated for proper identification and operation/maintenance of mechanical systems and equipment.
- 2.1.2.1 Multiple Systems: Where multiple systems of same generic name are indicated, provide identification that indicates individual system number as well as service such as "Boiler No. 3," "Air Supply No. 1H," or "Standpipe F12."
- 2.2 GROUT:
- 2.2.1 Nonshrink, Nonmetallic Grout: ASTM C 1107 Grade B.
- 2.2.1.1 Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
- 2.2.1.2 Design Mix 5000-psi (34.50-MPa), 28-day compressive strength.
- 2.1.3 Packaging: Premixed and factory-packaged

### PART 3. EXECUTION

- 3.2.1 Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Contracting Officer's representative.
- 3.2.2 Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.
- 3.2.3 Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

- 3.2.4 Equipment: Install engraved plastic laminate sign or equipment marker on or near each major item of mechanical equipment.
- 4.1 Lettering Size: Minimum 1/4-inch (6-mm) -high lettering for name of unit where viewing distance is less than 2 feet (0.6 m), 1/2-inch (13-mm) -high for distances up to 6 feet (1.8 m), and proportionately larger lettering for greater distances. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.
- 2.4.2 Text of Signs: Provide text to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to name of identified unit.
- 3.1 **PAINTING AND FINISHING:**
  - 1.1 Damage and Touch Up: Repair marred and damaged factory- painted finishes with materials and procedures to match original factory finish.
- 3.2 **ERECTION OF METAL SUPPORTS AND ANCHORAGE**
  - 2.1 Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment
  - 3.2.2 Field Welding: Comply with AWS D1.1 "Structural Welding Code--Steel."
- 3.3 **ERECTION OF WOOD SUPPORTS AND ANCHORAGE:**
  - 3 3.1 Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.
  - 3 Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

- 3.3.3 Attach to substrates as required to support applied loads.

DEMOLITION:

- 1 Disconnect, demolish, and remove work specified under Division 15 and as indicated.
- 2 Where pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
- 3 Removal: Remove indicated equipment from the Project site.

CUTTING AND PATCHING:

- 3.5.1 Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.
- 3.5.2 Repair cut surfaces to match adjacent surfaces.

END OF SECTION 15050

## SECTION 15250 - MECHANICAL INSULATION

### PART 1. GENERAL

#### 1.1 SUMMARY:

1.1.1 This Section includes duct insulation.

#### 1.2 DEFINITIONS:

1.2.1 Dual-Temperature Surfaces: Normal operating temperatures that vary from hot to cold.

1.2.2 Thermal resistivity is designated by an r-value that represents the reciprocal of thermal conductivity (k-value). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1 inch (25.4 mm) thick. Thermal resistivity (r-value) is expressed by the temperature difference in degrees Fahrenheit (Kelvins) between the two exposed faces required to cause 1 BTU per hour (1 Watt) to flow through 1 square foot (1 square meter) at mean temperatures indicated.

1.2.3 Thermal Conductivity (k-value): Measure of heat flow through a material at a given temperature difference; conductivity is expressed in units of Btu x inch/h x sq. ft. x deg F (W x m/sq. m x K).

1.2.4 Density: Is expressed in pcf (kg/cu. m)

#### 1.3 SUBMITTALS:

1.3.1 General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1.3.2 Product data for each type of mechanical insulation identifying k-value, thickness, and accessories.

1.3.3 Material certificates, signed by the manufacturer, certifying that materials comply with specified requirements where laboratory test reports cannot be obtained.

1.4 QUALITY ASSURANCE:

1.4.1 Fire Performance Characteristics: Conform to the following characteristics for insulation including facings, cements, and adhesives, when tested according to ASTM E 84, by UL or other testing or inspecting organization acceptable to the authority having jurisdiction. Label insulation with appropriate markings of testing laboratory.

1.4.1.1 Interior Insulation: Flame spread rating of 25 or less and a smoke developed rating of 50 or less.

1.4.1.2 Exterior Insulation: Flame spread rating of 75 or less and a smoke developed rating of 150 or less.

SEQUENCING AND SCHEDULING:

1.5.1 Schedule insulation application after testing of duct systems.

PART 2. PRODUCTS

2.1 MANUFACTURERS:

2.1.1 Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

2.1.1.1 Glass Fiber:

2.1.1.1.1 CertainTeed Corporation.

2.1.1.1.2 Knauf Fiberglass GmbH.

2.1.1.1.3 Manville

2.1.1.1.4 Owens-Corning Fiberglas Corporation.

2.1.1.1.5 USG Interiors, Inc. - Thermafiber Division

GLASS FIBER:

2.2.1 Material: Inorganic glass fibers, bonded with a thermosetting resin.

- 2 Jacket: All-purpose, factory-applied, laminated glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil having self-sealing lap.
- 2.2.3 Board ASTM C 612, Class 2, semi-rigid jacketed board.
- 3.1 Thermal Conductivity: 0.26 average maximum, at 75 deg F mean temperature.
- 3.2 Density: 12 Pcf average maximum
- 4 Blanket: ASTM C 553, Type II, Class F-1, jacketed flexible blankets.
- 2.2.5 Blanket: ASTM C 553, Type II, Class F-1, jacketed flexible blankets.
- 5.1 Thermal Conductivity: 0.32 Btu x inch/h x sq. ft. x deg F (0.046 W x m/sq. m x K) average maximum, at 75 deg F (24 deg C) mean temperature.
- 2.2.6 Adhesive: Produced under the UL Classification and Follow-up service.
- 2.2.6.1 Type: Non-flammable, solvent-based.
- 2.2.6.2 Service Temperature Range: Minus 20 to 180 deg F (Minus 29 to 82 deg C).
- 2.2.7 Vapor Barrier Coating: Waterproof coating recommended by insulation manufacturer for outside service.
- 2.3 INSULATING CEMENTS:
- 2.3.1 Mineral Fiber: ASTM C 195
- 2.3.1.1 Thermal Conductivity: 1.0 Btu x inch/h x sq. ft. x deg F (0.14 W x m/sq. m x K) average maximum at 500 deg F (260 deg C) mean temperature.
- 2.3.1.2 Compressive Strength: 10 psi (70 kPa) at 5 percent deformation.
- 2.3.2 Mineral Fiber, Hydraulic-Setting Insulating and Finishing Cement: ASTM C 449.

- 2.3.2.1 Thermal Conductivity: 1.2 Btu x inch/h x sq. ft. x deg F (0.173 W x m/sq. m x K) average maximum at 400 deg F (204 deg C) mean temperature.
- 2.3.2.2 Compressive Strength 100 psi (690 kPa) at 5 percent deformation.
- 2.4 **ADHESIVES:**
  - 2.4.1 Lagging Adhesive: MIL-A-3316C, non-flammable adhesive in the following Classes and Grades:
    - 2.4.1.1 Class 2, Grade A for bonding glass fiber insulation to metal surfaces.
- 2.5 **JACKETS:**
  - 2.5.1 General: ASTM C 921, Type 1, except as otherwise indicated.
  - 2.5.2 Foil and Paper Jacket: Laminated glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.
    - 2.5.2.1 Water Vapor Permeance: 0.02 perm (1.2 ng/Pa/s/sq. m) maximum, when tested according to ASTM E 96.
    - 2.5.2.2 Puncture Resistance: 50 beach units minimum, when tested according to ASTM D 781.
- 2.6 **ACCESSORIES AND ATTACHMENTS:**
  - 2.6.1 Glass Cloth and Tape: Woven glass fiber fabrics, plain weave, presized a minimum of 8 ounces per sq. yd. (272 gm per sq. m).
    - 2.6.1.1 Tape Width: 4 inches 102 mm)
    - 2.6.1.2 Cloth Standard: MIL-C-20079H, Type I
    - 2.6.1.3 Tape Standard: MIL-C-20079H, Type II
  - 2.6.2 Bands: 3/4 inch (19 mm) wide, in one of the following materials compatible with jacket:
    - 2.6.2.1 Stainless Steel: Type 304, 0.020 inch (0.5 mm) thick.
    - 2.6.2.2 Galvanized Steel: 0.005 inch (0.13 mm) thick

- 2.6.2.3 Aluminum 0.007 inch (0.18 mm) thick
- 2.6.2.4 Brass: 0.01 inch (0.25 mm) thick
- 2.6.2.5 Nickel-Copper Alloy 0.005 inch (0.13 mm) thick
- 3 Anchor Pins: Capable of supporting 20 pounds (9 kg) each. Provide anchor pins and speed washers of sizes and diameters as recommended by the manufacturer for insulation type and thickness.

**SEALING COMPOUNDS:**

- 2.7.1 Vapor Barrier Compound: Water-based, fire-resistive composition.
  - 2.7.1.1 Water Vapor Permeance: 0.08 perm (4.6 ng/Pa/s/sq m) maximum.
  - 2.7.1.2 Temperature Range Minus 20 to 180 deg F (Minus 29 to 82 deg C).
- 2 Weatherproof Sealant: Flexible-elastomer-based, vapor barrier sealant designed to seal metal joints.
  - 2.7.2.1 Water Vapor Permeance: 0.02 perm (1.2 ng/Pa/s/sq. m) maximum.
  - 2.7.2.2 Temperature Range: Minus 50 to 250 deg F (Minus 46 to 121 deg C).
- 2.3 Color: Aluminum.

**PART 3. EXECUTION**

- 1 **PREPARATION:**
  - 3.1.1 Surface Preparation: Clean, dry, and remove foreign materials such as rust, scale, and dirt.
  - 3.1.2 Mix insulating cements with clean potable water. Mix insulating cements contacting stainless-steel surfaces with demineralized water.
    - 3.1.2.1 Follow cement manufacturer's printed instructions for mixing and portions.

### INSTALLATION, GENERAL:

- 3.2.1 Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each mechanical system.
- 3.2.2 Select accessories compatible with materials suitable for the service. Select accessories that do not corrode, soften, or otherwise attack the insulation or jacket in either the wet or dry state.
- 3.2.3 Install vapor barriers on insulated ducts, and equipment having surface operating temperatures below 60 deg F (16 deg C).
- 3.2.4 Apply insulation material, accessories, and finishes according to the manufacturer's printed instructions
- 5 Install insulation with smooth, straight, and even surfaces.
- 3.2.6 Seal joints and seams to maintain vapor barrier on insulation requiring a vapor barrier.
- 3.2.7 Seal penetrations for hangers, supports, anchors, and other projections in insulation requiring a vapor barrier.
- 3.2.8 Seal Ends: Except for flexible elastomeric insulation, taper ends at 45 degree angle and seal with lagging adhesive. Cut ends of flexible elastomeric cellular insulation square and seal with adhesive.
- 3.2.9 Apply adhesives and coatings at manufacturer's recommended coverage-per-gallon rate.
- 3.2.10 Keep insulation materials dry during application and finishing.

### DUCT INSULATION:

- 3.3.1 Install block and board insulation as follows:
  - 3.3.1.1 Adhesive and Bank Attachment: Secure block and board insulation tight and smooth with a least 50 percent coverage of adhesive. Install bands spaced 12 inches apart. Protect insulation under bands and at exterior corners with metal corner angles. Fill joints, seams, and chipped edges with vapor barrier compound.

- 3.3.1.2 Speed Washers Attachment: Secure insulation tight and smooth with speed washers and welded pins. Space anchor pins 18 inches apart each way and 3 inches from insulation joints. Apply vapor barrier coating compound to insulation in contact, open joints, breaks, punctures, and voids in insulation.
- 3.3.2 Blanket Insulation: Install tight and smooth. Secure to ducts having long sides or diameters as follows:
  - 2.1 Smaller Than 24 Inches (610 mm): Bonding adhesive applied in 6 inches (150 mm) wide transverse strips on 12 inches (300 mm) centers.
  - 2.2 24 Inches (610 mm) and Larger: Anchor pins spaced 12 inches (300 mm) apart each way. Apply bonding adhesive to prevent sagging of the insulation.
- 3.3.2.3 Overlap joints 3 inches (75 mm).
- 3.3.2.4 Seal joints, breaks, and punctures with vapor barrier compound.
- 3.4 **JACKETS:**
  - 3.4.1 Foil and Paper Jackets (FP): Install jackets drawn tight. Install lap or butt strips at joints with material same as jacket. Secure with adhesive. Install jackets with 1-1/2 inches (40 mm) laps at longitudinal joints and 3 inch (75 mm) wide butt strips at end joints.
    - 3.4.1.1 Seal openings, punctures, and breaks in vapor barrier jackets and exposed insulation with vapor barrier compound.
  - 2 Exterior Exposed Insulation: Install continuous aluminum jackets and seal all joints and seams with waterproof sealant.
  - 3 Install metal jacket with 2 inches (50 mm) overlap at longitudinal and butt joints. Overlap longitudinal joints to shed water. Seal butt joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel draw bands 12 inches (300 mm) on center and at butt joints.

3.5        APPLICATIONS:

- 3.5.1        General: Materials and thicknesses are specified in schedules at the end of this Section.
- 3.5.2        Duct Systems: Unless otherwise indicated, insulate the following duct systems:
- 3.5.2.1      Interior concealed supply, return and outside air ductwork.
- 3.5.2.2      Interior exposed supply, return and outside air ductwork.
- 3.5.2.3      Exterior exposed supply and return ductwork.
- 3.5.2.4      Interior exposed and concealed supply fans, air handling unit casings and outside air plenums.

3.6        DUCT SYSTEMS INSULATION SCHEDULE

INTERIOR CONCEALED HVAC SUPPLY AND RETURN DUCTS AND PLENUMS

<u>MATERIAL</u>	<u>FORM</u>	<u>INCHES</u>	<u>JACKET</u>
GLASS FIBER	BLANKET	1-1/2	NONE

INTERIOR EXPOSED HVAC SUPPLY AND RETURN DUCTS AND PLENUMS

<u>MATERIAL</u>	<u>FORM</u>	<u>INCHES</u>	<u>JACKET</u>
GLASS FIBER RECT.	BOARD	1-1/2	NONE
GLASS FIBER ROUND	PIPE	1-1/2	NONE

EXTERIOR CONCEALED HVAC SUPPLY AND RETURN DUCTS AND PLENUMS

<u>MATERIAL</u>	<u>FORM</u>	<u>INCHES</u>	<u>JACKET</u>
GLASS FIBER RECT.	BOARD	2	NONE
GLASS FIBER ROUND	PIPE	2	NONE

END OF SECTION 15250

## SECTION 15530 - REFRIGERANT PIPING

### PART 1. GENERAL

#### 1.1 SUMMARY:

- 1.1.1 This Section includes refrigerant piping used for air-conditioning applications, including pipes, tubing, fittings, and specialties; special-duty valves; and refrigerants.

#### 1.2 SUBMITTALS:

- 1.2.1 General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- 1.2.2 Product Data for each valve type and refrigerant piping specialty specified.

#### 1.3 QUALITY ASSURANCE:

- 1.3.1 ASME Compliance: Qualify brazing and welding processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."
- 1.3.2 Regulatory Requirements: Comply with provisions of the following codes:
  - 1.3.2.1 ASME B31.5, "Refrigeration Piping."
  - 1.3.2.2 ASHRAE 15, "Safety Code for Mechanical Refrigeration."
- 1.3.3 UL Standard: Provide products complying with UL 207 "Refrigerant-Containing Components and Accessories, Nonelectrical"; or UL 429, "Electrically Operated Valves."
- 3.4 Listing and Labeling: Provide products specified in this Section that are UL listed and labeled.

#### EXTRA MATERIALS:

- 1 Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

- 1.4.1.1 Refrigeration Oil Test Kits: 2 each, containing everything required to conduct 1 test.
- 1.4.1.2 Refrigerant: 2 containers each, with 20 lb (9 kg) of refrigerant.
- 1.4.1.3 Filter-Dryer Cartridges: 3 of each type

## **PART 2. PRODUCTS**

### **2.1 MANUFACTURERS:**

- 2.1.1 Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

#### **1.1 Refrigerants:**

- 2.1.1.1.1 Allied Signal Inc.; Genetron Refrigerants.

#### **1.1.2 DuPont Company; Fluorochemicals Div.**

- 2.1.1.2 Refrigerant Valves and Specialties:

- 2.1.1.2.1 Danfoss Electronics, Inc

- 2.1.1.2.2 Eaton Corporation; Industrial Control Div.

- 2.1.1.2.3 Emerson Electric Company; Alco Controls Div.

- 2.1.1.2.4 Sporlan Valve Company.

### **2.2 PIPES AND TUBES:**

- 2.2.1 Hard Copper Tube: ASTM B 280, Type ACR, drawn temper.

#### **PIPE AND TUBE FITTINGS:**

- 2.3.1 Copper Fittings: ASME B16.22, wrought-copper streamlined pattern.

2.4 JOINING MATERIALS:

- 2.4.1 Brazing Filler Metals: AWS A5.8, Classification BAg-1 (Silver).

2.5 VALVES:

- 2.5.1 Diaphragm Packless Valves: 500-psig (3450-kPa) working pressure and 275 deg F (135 deg C) working temperature, globe or angle pattern, forged-brass or bronze body and bonnet, phosphor bronze and stainless-steel diaphragms, rising stem and handwheel, stainless-steel spring, nylon seat disc, with solder-end connections.
- 2.5.2 Packed-Angle Valves: 500-psig (3450-kPa) working pressure and 275 deg F (135 deg C) working temperature forged-brass or bronze body, forged-brass seal caps with copper gasket, back seating, rising stem and seat molded stem packing, with solder-end connections.
- 2.5.3 Check Valves--Smaller than 1-Inch NPS (DN25): 500-psig (3450-kPa) operating pressure, 300 deg F (149 deg C) operating temperature; cast-brass body, with removable piston, PTFE seat, and stainless-steel spring; straight-through globe design. Valve shall be straight-through pattern, with solder-end connections.
- 2.5.4 Check Valves--Larger than 1-Inch NPS (DN25): 450-psig (3100-kPa) operating pressure, 300 deg F (149 deg C) operating temperature; cast-bronze body, with cast-bronze or forged-brass bolted bonnet; floating piston with mechanically retained PTFE seat disc. Valve shall be straight-through or angle pattern, with solder-end connections.
- 2.5.5 Service Valves: 500-psig (3450-kPa) pressure rating, forged-brass body with copper stubs, brass caps, removable valve core, integral ball check valve, with solder-end connections.
- 2.5.6 Solenoid Valves: Conform to ARI 760; 250 deg F (121 deg C) temperature rating, 400-psig (2760-kPa) working pressure; forged brass, with PTFE valve seat, 2-way straight-through pattern, and solder-end connections; manual operator; with NEMA 250, Type 1 solenoid enclosure with 1/2-inch (13-mm) conduit adapter, and 24-V normally closed holding coil.

- 2.5.7 Pressure-Regulating Valves: Conform to ARI 770; direct acting, brass with pilot operator, stainless-steel diaphragm, standard coil, and solder-end connections.
- 2.5.8 Pressure Relief Valves: Straight or angle brass body and disc, neoprene seat, factory sealed and ASME labeled, for standard pressure setting.
- 2.5.9 Thermal Expansion Valves: Conform to ARI 750; thermostatic- adjustable, modulating type; size as required and factory set for superheat requirements; solder-end connections; with sensing bulb, distributor having side connection for hot-gas bypass line, and external equalizer line.
- 2.5.10 Hot-Gas Bypass Valve: Adjustable, sized for capacity equal to last step of compressor unloading; solder-end connections.
- 2.6 **REFRIGERANT PIPING SPECIALTIES:**
  - 2.6.1 Straight- or Angle-Type Strainers: 430-psig (2960-kPa) working pressure; forged-brass or steel body with stainless- steel wire or brass-reinforced Monel screen, and screwed cleanout plug, with solder-end connections.
  - 2.6.2 Moisture/Liquid Indicators: 500-psig (3450-kPa) operating pressure, 200 deg F (93 deg C) operating temperature; forged-brass body, with replaceable, polished, optical viewing window with color-coded moisture indicator, and solder-end connections.
  - 2.6.3 Replaceable-Core Filter-Dryers: 500-psig (3450-kPa) operating pressure; steel shell, flange ring, and spring, ductile-iron cover plate with steel cap screws, and wrought- copper fittings for solder-end connections; with replaceable-core kit, including gaskets, as follows:
    - 2.6.3.1 Filter Cartridge: Pleated media with integral end rings, stainless-steel support, ARI 730 rated for capacity.
  - 2.6.4 Permanent Filter-Dryer: 350-psig (2140-kPa) maximum operating pressure, 225 deg F (107 deg C) maximum operating temperature; steel shell, and wrought-copper fittings for solder-end connections; molded-felt core surrounded by desiccant.

- 2.6.5 Flanged Unions: 400-psig (2760-kPa) working pressure, 330 deg F (165 deg C) maximum operating temperature; 2 brass tailpiece adapters for solder-end connections to copper tubing; forged-steel flanges for 1- to 1-1/2-inch (22- to 41-mm) nominal copper-tube size and ductile iron for 2- to 3-inch (54- to 79-mm) nominal copper-tube size with 4 plated steel bolts, with silicon bronze nuts and fiber gasket; factory-applied rust-resistant coating on flanges and bolts.
- 2.6.6 Flexible Connectors: 500-psig (3450-kPa) operating pressure; seamless tin-bronze or stainless-steel core, high- tensile bronze-braid covering, solder-end connections, and synthetic covering; dehydrated, pressure tested, minimum 7 inches (180 mm) long.
- 2.6.7 Mufflers: 500-psig (3450-kPa) operating pressure, brazed- steel construction with fusible plug, sized for refrigeration capacity.

**RECEIVERS:**

- 2.7.1 6-Inch (150-mm) Diameter and Smaller: ARI 495, UL listed, steel, brazed; 400-psig (2760-kPa) pressure rating, with tappings for inlet, outlet, and pressure relief valve.
- 2.7.2 More than 6-Inch (150-mm) Diameter: ARI 495, welded steel, tested and stamped according to ASME Boiler and Pressure Vessel Code, Section 8D; 400 psig (2760 kPa) with tappings for liquid inlet and outlet valves, pressure relief valve, and liquid-level indicator.

**REFRIGERANT:**

- 2.8.1 ASHRAE 34, R-22: Monochlorodifluoromethane.

**PART 3. EXECUTION**

**EXAMINATION:**

- 3.1.1 Examine roughing-in for compliance with requirements for installation tolerances and other conditions affecting performance of refrigerant piping. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2        APPLICATIONS:

- 3.2.1      Aboveground, within Building: Type L (Type B) drawn-copper tubing.

3.3        INSTALLATION:

- 3.3.1      Install refrigerant piping according to ASHRAE 15
- 3.3.2      Install piping in short and direct arrangement, with minimum number of joints, elbows, and fittings.
- 3.3.3      Arrange piping to allow normal inspection and service of compressor and other equipment. Install valves and specialties in accessible locations to allow for service and inspection.
- 3.3.4      Install piping with adequate clearance between pipe and adjacent walls and hangers, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
- 3.3.5      Insulate suction lines and liquid lines, but insulate them together if adjacent.
- 3.3.5.1    Do not install insulation until system testing has been completed and all leaks have been eliminated.
- 3.3.6      Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.
- 3.3.7      Slope refrigerant piping as follows:
- 3.3.7.1    Install horizontal hot-gas discharge piping with a uniform slope of 0.4 percent downward away from compressor.
- 3.3.7.2    Install horizontal suction lines with a uniform slope of 0.4 percent downward to compressor.
- 3.3.7.3    Install traps and double risers where indicated and where required to entrain oil in vertical runs.
- 3.3.7.4    Liquid lines may be installed level

- 3.3.8 Use fittings for changes in direction and branch connections.
- 3.3.9 Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- 3.3.10 Reduce pipe sizes using eccentric reducer fittings installed with level side down.
  - 11 Provide bypass around moisture-liquid indicators in lines larger than 2-inch NPS (DN50).
- 3.3.12 Install unions to allow removal of solenoid valves, pressure-regulating valves, expansion valves, and at connections to compressors and evaporators.
- 3.3.13 Install flexible connectors at the inlet and discharge connection, at right angles to axial movement of compressor, parallel to crankshaft.
  - 14 Install replaceable-core filter-dryers, with isolation valves and valved bypass.
- 3.3.15 Install refrigerant valves according to manufacturer's written instructions.
- 3.3.16 When brazing, remove solenoid-valve coils; remove sight glasses; and remove stems, seats, and packing of valves, and accessible internal parts of refrigerant specialties. Do not apply heat near bulb of expansion valve.
- 3.3.17 Electrical wiring for solenoid valves is specified in Division 16 Sections. Coordinate electrical requirements and connections.
- 3.3.18 Mount thermostatic expansion valves in any position close to evaporator.
  - 3.3.18.1 Where refrigerant distributors are used, mount directly on expansion-valve outlet.
  - 3.3.18.2 Install valve so diaphragm case is warmer than bulb.
    - 18.3 Secure bulb to clean, straight, horizontal section of suction line using 2 bulb straps. Do not mount bulb in a trap or at the bottom of the line.

- 3.3.18.4 Where external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- 3.3.19 Install pressure relief valves as required by ASHRAE 15. Pipe pressure relief valves on receivers to outdoors.
- 3.3.20 Charge and purge systems, after testing, and dispose of refrigerant following ASHRAE 15 procedures.
- 3.3.21 Charge system as follows:
  - 3.3.21.1 Install filter-dryer core after leak test, but before evacuation.
  - 3.3.21.2 Evacuate refrigerant system with vacuum pump, until temperature of 35 deg F (1.7 deg C) is indicated on vacuum dehydration indicator.
  - 3.3.21.3 Maintain vacuum for a minimum of 5 hours
  - 3.3.21.4 Break vacuum with refrigerant gas and charge to 2 psig (14 kPa).

#### HANGERS AND SUPPORTS:

- 3.4.1 Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) in length.
- 3.4.2 Roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.
- 3.4.3 Pipe rollers for multiple horizontal runs, 20 feet (6 m) or longer supported by a trapeze.
- .4 Spring hangers to support vertical runs.
- 3.4.5 Install hangers for copper tubing with the following maximum spacing and minimum rod sizes. Tube sizes are nominal or standard tube sizes as expressed in ASTM B 88 (ASTM B 88M).
  - 3.4.5.1 1/2 Inch (15 mm): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.3 mm).
  - 5.2 5/8 Inch (18 mm): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.3 mm).

- 3.4.5.3 1 Inch (28 mm): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.3 mm).
- 3.4.5.4 1-1/4 Inches (35 mm): Maximum span, 72 inches (1800 mm); minimum rod size, 1/4 inch (6.3 mm).
- 3.4.5.5 1-1/2 Inches (42 mm): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
- 3.4.5.6 2 Inches (54 mm): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
- 3.4.5.7 2-1/2 Inches (67 mm): Maximum span, 108 inches (2700 mm); minimum rod size, 3/8 inch (9.5 mm).
- 3.4.5.8 3 Inches (79 mm): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
- 3.4.5.9 4 Inches (105 mm): Maximum span, 12 feet (3.6 m); minimum rod size, 1/2 inch (12.7 mm).

3.4.6 Support vertical runs at each floor.

### 3.5 PIPE JOINT CONSTRUCTION:

- 3.5.1 Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide) during brazing to prevent formation of scale.

### 3.6 VALVE INSTALLATIONS:

- 3.6.1 Install refrigerant valves according to manufacturer's written instructions.
- 3.6.2 Install valves on suction and discharge of compressor, for gage taps at compressor inlet and outlet, for gage taps at hot-gas bypass regulators, on inlet and outlet, and on each side of strainers.
- 3.6.3 Install check valves on compressor discharge and on condenser liquid lines on multiple condenser systems.
- 3.6.4 Install refrigerant-charging (packed-angle) valve in liquid line between receiver shutoff valve and expansion valve.

- 3.6.5 Install globe valves on each side of strainers and dryers, in liquid and suction lines at evaporators, and elsewhere as indicated.
- 3.6.6 Install a full-sized, 3-valve bypass around each dryer
- 3.6.7 Install solenoid valves ahead of each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
  - 3.6.7.1 Electrical wiring for solenoid valves is specified in Division 16 Sections. Coordinate electrical requirements and connections.
- 3.6.8 Mount thermostatic expansion valves in any position, close to evaporator.
  - 3.6.8.1 Where refrigerant distributors are used, mount directly on expansion-valve outlet.
  - 3.6.8.2 Install valve so diaphragm case is warmer than bulb.
  - 3.6.8.3 Secure bulb to clean, straight, horizontal section of suction line using 2 bulb straps. Do not mount bulb in a trap or at the bottom of the line.
  - 3.6.8.4 Where external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- 3.6.9 Install pressure-regulating and relief valves as required by ASHRAE 15.
- 3.7 **SPECIALTIES APPLICATION AND INSTALLATION:**
  - 3.7.1 Install liquid indicators in liquid line leaving condenser, in liquid line leaving receiver, and on leaving side of liquid solenoid valves.
  - 3.7.2 Install strainers immediately upstream of each automatic valve, including expansion valves, solenoid valves, hot-gas bypass valves, and compressor suction valves.
  - 3.7.3 Install strainers on main liquid line where multiple expansion valves with integral strainers are used.
  - 3.7.4 Install strainers in suction line of steel pipe.

- 3.7.5 Install moisture-liquid indicators in liquid lines between filter-dryers and thermostatic expansion valves and in liquid line to receiver.
- 3.7.6 Install pressure relief valves on ASME receivers, and pipe to outdoors.
- 3.7.7 Install replaceable-core filter-dryers in vertical liquid line adjacent to receivers and before each solenoid valve.
- 3.7.8 Install permanent filter-dryers in low-temperature systems, in systems using hermetic compressors, and before each solenoid valve.
- 3.7.9 Install solenoid valves in liquid line of systems operating with single pump-out or pump-down compressor control, in liquid line of single or multiple evaporator systems, and in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into suction line when system shuts down.
- 3.7.10 Install flexible connectors at or near compressors where piping configuration does not absorb vibration.
- 3.8 **CONNECTIONS:**
- 3.8.1 Electrical: Conform to applicable requirements of Division 16 Sections for electrical connections.
- 3.9 **FIELD QUALITY CONTROL:**
- 3.9.1 Inspect and test refrigerant piping according to ASME B31.5, Chapter VI.
- 3.9.1.1 Pressure test with nitrogen to 200 psig (1380 kPa). Perform final tests at 27-psig (186-kPa) vacuum and 200 psig (1380 kPa) using halide torch or electronic leak detector. Test to no leakage.
- 3.9.2 Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- 3.9.3 Repair leaks using new materials; retest.
- 3.10 **ADJUSTING:**
- 3.10.1 Adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

3.11        CLEANING:

- 3.11.1      Before installation of copper tubing other than Type ACR, clean tubing and fittings with trichloroethylene.

3.12        COMMISSIONING:

- 3.12.1      Charge system using the following procedures:
- 3.12.1.1    Install core in filter dryer after leak test, but before evacuation.
- 3.12.1.2    Evacuate refrigerant system with vacuum pump until temperature of 35 deg F (1.67 deg C) is indicated on vacuum dehydration indicator.
- 3.12.1.3    During evacuation, apply heat to pockets, elbows, and low spots in piping.
- 3.12.1.4    Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
- 3.12.1.5    Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
- 3.12.1.6    Complete charging of system, using new filter-dryer core in charging line. Provide full-operating charge

END OF SECTION 15530

## SECTION 15782 - ROOFTOP UNITS

### PART 1. GENERAL

#### SUMMARY:

- 1.1.1 This Section includes rooftop heating and cooling units.

#### 1.2 SUBMITTALS:

- 1.2.1 Product Data: Include manufacturer's technical data for each model indicated, including rated capacities of selected model clearly indicated; dimensions; required clearances; shipping, installed, and operating weights; furnished specialties; accessories; and installation and startup instructions.
- 1.2.2 Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
  - 1.2.2.1 Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
- 1.2.3 Warranties: Special warranties specified in this Section.

#### QUALITY ASSURANCE:

- 1.3.1 Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
- 1.3.2 Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.
  - 1.3.2.1 The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
  - 1.3.2.2 Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- 1.3.3 Comply with NFPA 70.

**DELIVERY, STORAGE, AND HANDLING:**

- 1.4.1 Deliver rooftop units as factory-assembled units with protective crating and covering.
- 1.4.2 Coordinate delivery of units in sufficient time to allow movement into building.
- 1.4.3 Handle rooftop units to comply with manufacturer's written rigging and installation instructions for unloading and moving to final location.

**COORDINATION:**

- 1.5.1 Coordinate installation of equipment supports, and roof penetrations with roof construction.

**1.6 WARRANTY:**

- 1.6.1 General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- 1.6.2 Special Warranty: A written warranty, executed by the manufacturer and signed by the Contractor, agreeing to replace components that fail in materials or workmanship, within the specified warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed.
  - 1.6.2.1 Warranty Period, Compressors: Manufacturers standard, but not less than 5 years after date of Substantial Completion.

**1.7 EXTRA MATERIALS:**

- 1.7.1 Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
  - 1.7.1.1 Fan Belts: One set for each belt-drive fan.
  - 1.7.1.2 Filters: One set of filters for each unit

## PART 2. PRODUCTS

### MANUFACTURERS:

- 2.1.1 Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2.1.1.1 Rooftop Units, 7-1/2 Tons (21 kW) and Smaller:
    - 2.1.1.1.1 Carrier Corp.; Carrier Air Conditioning Div.
    - 2.1.1.1.2 Lennox Industries Inc
    - 2.1.1.1.3 McQuay International
    - 2.1.1.1.4 Trane Company (The); North American Commercial Group.
    - 2.1.1.1.5 York International Corp.

### ROOFTOP UNITS SMALLER THAN 7-1/2 TONS:

- 2.2.1 Description: Factory assembled and tested; designed for roof or slab installation; and consisting of compressors, condensers, evaporator coils, condenser and evaporator fans, refrigeration and temperature controls, filters, and dampers.
- 2.2.2 Casing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, removable panels or access doors with neoprene gaskets for inspection and access to internal parts, minimum 1/2-inch- (13-mm-) thick thermal insulation, knockouts for electrical and piping connections, exterior condensate drain connection, and lifting lugs.
- 2.2.3 Evaporator Fans: Forward curved, centrifugal, directly driven with permanently lubricated motor bearings.
- 2.2.4 Condenser Fans: Propeller type, directly driven with permanently lubricated motor bearings.
- 2.2.5 Refrigerant Coils: Aluminum-plate fin and seamless copper tube in galvanized steel casing with equalizing-type vertical distributor.

- 2.2.6 Compressors: Hermetic with integral vibration isolators and crankcase heaters.
- 2.2.7 Electric Heat: Manufacturer's standard construction, factory wired for single-point wiring connection, with overcurrent and overheat protection devices.
- 2.2.8 Economizer Control: Return- and outside-air dampers, outside-air filter, fully modulating electronic-control system with adjustable mixed-air thermostat and automatic changeover.
- 2.2.9 Low Ambient Control: Head-pressure control, designed to operate at temperatures as low as 0 deg F (minus 18 deg C).
- 2.2.10 Thermostat: Programmable, electronic; with heating setback and cooling setup with 7-day programming.
- 2.2.11 Smoke Detectors: Photoelectric detector located in return- air plenum, to de-energize unit.

**MOTORS:**

- 2.3.1 Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.
- 2.3.2 Enclosure Type: Open, dripproof

**SOURCE QUALITY CONTROL:**

- 2.4.1 Verification of Performance: Rate capacity according to ARI 210/240, "Unitary Air-Conditioning and Air Source Heat Pump Equipment."
- 2.4.1.1 Sound Power Level Ratings: Comply with ARI 270 "Standard for Sound Rating of Outdoor Unitary Equipment."

**PART 3. EXECUTION**

**EXAMINATION:**

- 3.1.1 Examine roof for compliance with requirements for conditions affecting installation and performance of rooftop units. Prior to installation that unsatisfactory conditions exist, inform Contracting Officer Representative.

**INSTALLATION:**

- 3.2.1 Install units according to manufacturer's written instructions.
- 3.2.2 Install units level and plumb, maintaining manufacturer's recommended clearances.
- 3.2.3 Curb Support: Install unit on roof structure, level, according to NRCA's written installation instructions. Install and secure rooftop units on treated wood and coordinate roof penetrations and flashing with roof construction.

**3.3 CONNECTIONS:**

- 3.3.1 Duct installation requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
  - 3.3.1.1 Install ducts to termination in roof mounting frames. Where indicated, terminate return-air duct through roof structure and insulate space between roof and bottom of unit.
- 3.3.2 Electrical: Conform to applicable requirements in Division 16 Sections.
  - 3 Ground equipment.
- 3.3.3.1 Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

**COMMISSIONING:**

- 1 Verify that installation is as indicated and specified.
- 2 Complete manufacturer's installation and startup checks and perform the following:
  - 2.1 Level unit on housekeeping base, and flash curbs to unit and to roof.
- 3.4.2.2 Inspect for visible damage to unit casing.

- 2.3 Inspect for visible damage to compressor, air-cooled condenser coil, and fans.
- 3.4.2.4 Verify that clearances have been provided for servicing.
- 3.4.2.5 Check that labels are clearly visible.
- 3.4.2.6 Verify that controls are connected and operable
- 3.4.2.7 Remove shipping bolts, blocks, and tie-down straps.
- 3.4.2.8 Verify that filters are installed
- .2.9 Adjust vibration isolators.
- 2.10 Check acoustic insulation
- 2.11 Check operation of barometric dampers
- 3 Lubricate bearings on fan.
- 3.4.4 Check fan-wheel rotation for correct direction without vibration and binding.
- 3.4.5 Adjust fan belts to proper alignment and tension.
- 3.4.6 Start unit according to manufacturer's written instructions.
- 3.4.6.1 Perform starting of refrigeration in summer only.
- 3.4.6.2 Complete startup sheets and attach copy with Contractor's startup report.
- 3.4.7 Check and record performance of interlocks and protection devices; verify sequences.
- 3.4.8 Operate unit for an initial period as recommended or required by manufacturer.
- 3.4.9 Calibrate thermostats
- 3.4.10 Adjust and check high-temperature limits.
- 3.4.11 Check internal isolators.

- 3.4.12 Check outside-air damper for proper stroke interlock with return-air dampers.
- 3.4.13 Check controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
- 3.4.14 Start refrigeration and measure and record following:
  - 3.4.14.1 Coil leaving-air, dry- and wet-bulb temperatures.
  - 3.4.14.2 Coil entering-air, dry- and wet-bulb temperatures
  - 3.4.14.3 Outside-air, dry-bulb temperature
  - 3.4.14.4 Air-cooled-condenser, discharge-air, dry-bulb temperature.
- 3.4.15 Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
  - 3.4.15.1 Supply-air volume.
  - 3.4.15.2 Return-air volume.
  - 3.4.15.3 Relief-air volume.
  - 3.4.15.4 Outside-air intake volume
- 3.4.16 Simulate maximum cooling demand and check the following:
  - 3.4.16.1 Compressor refrigerant suction and hot-gas pressures.
  - 3.4.16.2 Short circuiting air through condenser or from condenser to outside-air intake.
- 3.4.17 After starting and performance testing, change filters, vacuum cooling and condenser coils, lubricate bearings, adjust belt tension.
- 3.5 **DEMONSTRATION:**
  - 3.5.1 Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

- 3.5.1.1 Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
- 3.5.1.2 Review data in the maintenance manuals. Refer to Division 1 Section "Contract Closeout."
- 3.5.1.3 Review data in the maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
- 3.5.1.4 Schedule training with Contracting Officer's Representative through Architect, with at least 7 days' advance notice.

END OF SECTION 15782

## SECTION 15886 - AIR FILTERS

### PART 1. GENERAL

#### SUMMARY:

- 1.1.1 This Section includes the following types of air filters and accessories:
  - 1.1.1.1 Replaceable (throwaway) panel filters.

#### SUBMITTALS:

- 1.2.1 General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
- 1.2.2 Product data including dimensions, weights, required clearances and access, flow capacity including initial and final pressure drop at rated air flow, efficiency and test method, and fire classification.

#### QUALITY ASSURANCE:

- 1.3.1 Fire Performance Characteristics: Provide filters identical with those tested for the fire performance characteristics indicated. Identify with appropriate markings of applicable testing and inspecting agency.
  - 1.3.1.1 Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- 1.3.2 NFPA Compliance: Comply with applicable portions of NFPA 90A and 90B pertaining to installing air filters
- 1.3.3 ASHRAE Compliance: Comply with provisions of ASHRAE Standard 52 for method of testing and rating air filter units.
- 1.3.4 ARI Compliance: Comply with provisions of ARI Standard 850 pertaining to testing and performance of air filter units.

#### DELIVERY, STORAGE, AND HANDLING:

- 1.4.1 Lift and support factory-assembled units only at designated lifting or supporting points, as indicated on shop drawings. Deliver with protective crating and covering.

**EXTRA MATERIALS:**

- 1.5.1.1 Provide one complete extra set of filters for each filter bank. If system includes prefilters and afterfilters, provide only prefilters.

**PART 2. PRODUCTS**

**MANUFACTURERS:**

- 2.1.1 Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
  - 2.1.1.1.1 American Air Filter Co
  - 2.1.1.1.2 Farr Co.
  - 2.1.1.1.3 Flanders Filters Inc
  - 2.1.1.1 Filter Gages:
    - 2.1.1.1.1 Cambridge Filter Corp.
    - 2.1.1.1.2 Dwyer Instruments, Inc.

**REPLACEABLE (THROWAWAY) PANEL FILTERS:**

- 2.2.1 Description: Factory-fabricated, viscous-coated, flat-panel type, replaceable air filters with holding frames in sizes and having performance characteristics as indicated.
- 2.2.2 Media: Throwaway media of interlaced glass fibers, sprayed with nonflammable adhesive.
- 2.2.3 Frame: Cardboard frame with perforated metal retainer
- 2.2.4 Frame: 20-gage (0.9mm) minimum galvanized steel with expanded metal grid on outlet side and steel rod grid on inlet side, hinged with pull and retaining handles.
- 2.2.5 Duct Holding Frames: 20-gage (0.9mm) galvanized steel capable of holding media and media frame in place, with gaskets to prevent unfiltered air bypass.

### PART 3. EXECUTION

#### INSTALLATION:

- 3.1.1 Install air filters and holding devices of types indicated and where shown following air filter manufacturer's written instructions and with recognized industry practices to ensure that filters comply with requirements and serve intended purposes.
- 3.1.2 Locate each filter unit accurately in position indicated in relation to other work. Position unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
- 3.1.3 Install filters in position to prevent passage of unfiltered air.
- 3.1.3.1 Install filter gage static-pressure tips upstream and downstream of filters to indicate air pressure drop through filter. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.

#### CONNECTIONS:

- 3.2.1 Coordinate filter installations with duct and air-handling unit installations.

#### CLEANING:

- 3.3.1 After testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 15886

## SECTION 15891 - METAL DUCTWORK

### PART 1. GENERAL

#### SUMMARY:

- 1.1.1 This Section includes rectangular, metal ducts and plenums for heating, ventilating, and air conditioning systems in pressure classes from minus 1 inch to plus 1 inch water gage.
- 1.1.2 Related Sections: The following sections contain requirements that relate to this Section:
  - 1.1.2.1 Division 15 Section "Mechanical Insulation" for exterior duct and plenum insulation.
  - 1.1.2.2 Division 15 Section "Duct Accessories" for flexible duct materials, dampers, duct-mounted access panels and doors, and turning vanes.

#### DEFINITIONS:

- 1.2.1 Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:
  - 1.2.1.1 Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
  - 1.2.1.2 Joints: Joints include girth joints; branch and subbranch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

#### SYSTEM PERFORMANCE REQUIREMENTS:

- 1.3.1 The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

**SUBMITTALS:**

- 1.4.1 General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- 1.4.2 Shop drawings from duct fabrication shop, drawn to a scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as the Contract Drawings, detailing:
  - 1.4.2.1 Duct layout, indicating pressure classifications and sizes in plan view.
  - 1.4.2.2 Fittings
  - 1.4.2.3 Reinforcing details and spacing.
  - 1.4.2.4 Seam and joint construction details.
  - 1.4.2.5 Penetrations through fire-rated and other partitions
  - 1.4.2.6 Terminal unit installation
  - 1.4.2.7 Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment

**QUALITY ASSURANCE:**

- 1.5.1 Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel" for hangers and supports and AWS D9.1 "Sheet Metal Welding Code."
- 1.5.2 Qualify each welder in accordance with AWS qualification tests for welding processes involved. Certify that their qualification is current.
- 1.5.3 NFPA Compliance: Comply with the following NFPA Standards:
  - 1.5.3.1 NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.

### DELIVERY, STORAGE, AND HANDLING:

- 1.6.1 Deliver sealant and fire-stopping materials to site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- 1.6.2 Store and handle sealant fire-stopping materials in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

### PART 2. PRODUCTS

#### 2.1 SHEET METAL MATERIALS:

- 2.1.1 Sheet Metal, General: Provide sheet metal in thicknesses indicated, packaged and marked as specified in ASTM A 700.
- 2.1.2 Galvanized Sheet Steel: Lock-forming quality, ASTM A 527, Coating Designation G 90. Provide mill phosphatized finish for exposed surfaces of ducts exposed to view.

#### 2.2 FIRE-STOPPING:

- 2.2.1 Fire-Resistant Sealant: Provide two-part, foamed-in-place, fire-stopping silicone sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

- 2 Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

- 2.2.2.1 "Dow Corning Fire Stop Foam"; Dow Corning Corp.
- 2.2.2.2 "Pensil 851"; General Electric Co

#### HANGERS AND SUPPORTS:

- 2.3.1 Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concretes or for slabs less than 4 inches thick.
- 2 Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod.
- 2.3.2.1 Hangers Installed In Corrosive Atmospheres: Electro-galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.
- 2.3.2.2 Straps and Rod Sizes: Conform with Table 4-1 in SMACNA HVAC Duct Construction Standards, 1985 Edition, for sheet steel width and gage and steel rod diameters.
- 2.3.3 Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

#### RECTANGULAR DUCT FABRICATION:

- 2.4.1 General: Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, in accordance with SMACNA "HVAC Duct Construction Standards," Tables 1-3 through 1-19, including their associated details. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications, and joint types and intervals.
- 2.4.1.1 Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
- 2.4.1.2 Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.
- 2.4.2 Static Pressure Classifications: Except where otherwise indicated, construct duct systems to the following pressure classifications:
  - 2.4.2.1 Supply Ducts: 1 inch water gage
  - 2.4.2.2 Return Ducts: 1 inch water gage, negative pressure.

- 2.4.3 Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20 gage or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standard," Figure 1-4, unless they are lined or are externally insulated.

**RECTANGULAR DUCT FITTINGS:**

- 2.5.1 Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," 1985 Edition, Figures 2-1 through 2-10.

**PART 3. EXECUTION**

**DUCT INSTALLATION, GENERAL:**

- 3.1.1 Duct System Pressure Class: Construct and install each duct system for the specific duct pressure classification indicated.
- 3.1.2 Install ducts with the fewest possible joints.
- 3.1.3 Use fabricated fittings for all changes in directions, changes in size and shape, and connections.
- 3.1.4 Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum
- 5 Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.
- 3.1.6 Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- 7 Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.
- 3.1.8 Install insulated ducts with 1-inch clearance outside of insulation.

- 3.1.9 Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- 3.1.10 Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 1-1/2 inches.

**SEAM AND JOINT SEALING:**

- 3.2.1 General: Seal duct seams and joints as follows:
- 3.2.2 Pressure Classification 1 Inch Water Gage: All transverse joints and longitudinal seams.
- 3.2.3 Seal externally insulated ducts prior to insulation installation.

**HANGING AND SUPPORTING:**

- 3.3.1 Install rectangular, metal duct with support systems indicated in SMACNA "HVAC Duct Construction Standards," Tables 4-1 through 4-3 and Figures 4-1 through 4-8.
- 3.3.2 Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.
- 3.3.3 Support vertical ducts at a maximum interval of 16 feet and at each floor.
- 3.3.4 Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated.

**CONNECTIONS:**

- 3.4.1 Equipment Connections: Connect equipment with flexible connectors in accordance with Division 15 Section "Duct Accessories."

**FIELD QUALITY CONTROL:**

- 3.5.1 Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.

**FIELD QUALITY CONTROL:**

- 3.6.1 Disassemble, reassemble, and seal segments of the systems as required to accommodate leakage testing, and as required for compliance with test requirements.
- 3.6.2 Maximum Allowable Leakage: As described in ASHRAE 1989 Handbook, "Fundamentals" Volume, Chapter 32, Table 6 and Figure 10. Comply with requirements for leakage classification 12 for rectangular ducts in pressure classifications less than and equal to 2 inches water gage (both positive and negative pressures).
- 3.6.3 Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.
- 3.6.4 Leakage Test: Perform volumetric measurements and adjust air systems as described in ASHRAE 1987 "HVAC Systems and Applications" Volume, Chapter 57 and ASHRAE 1989 "Fundamentals" Volume, Chapter 13.

**CLEANING:**

- 3.7.1 Vacuum ducts systems prior to final acceptance to remove dust and debris.

END OF SECTION 15891

## SECTION 15910 - DUCT ACCESSORIES

### PART 1. GENERAL

#### SUMMARY:

- 1.1.1 This Section includes the following:
  - 1.1.1.1 Turning vanes.
  - 1.1.1.2 Duct-mounted access doors and panels.
  - 1.1.1.3 Flexible connectors.
  - 1.1.1.4 Accessories hardware

#### SUBMITTALS:

- 1.2.1 General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- 1.2.2 Shop drawings from manufacturer detailing assemblies. Include dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

#### QUALITY ASSURANCE:

- 1.3.1 NFPA Compliance: Comply with the following NFPA Standards:
  - 1.3.1.1 NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
  - 1.3.1.2 NFPA 90B, "Standard for the Installation of Warm Air Heating and Air Conditioning Systems."

### PART 2. PRODUCTS

#### TURNING VANES:

- 2.1.1 Manufactured Turning Vanes: Fabricate of 1-1/2-inch-wide (38-mm-wide), curved blades set at 3/4 inch (19 mm) on center, support with bars perpendicular to blades set at 2 inches (50 mm) on center, and set into side strips suitable for mounting in ducts.

- 2.1.2 Acoustic Turning Vanes: Fabricate of airfoil-shaped aluminum extrusions with perforated faces and fiber glass fill.

**DUCT-MOUNTED ACCESS DOORS AND PANELS:**

- 2.2.1 Frame: Galvanized sheet steel. Provide with bend-over tabs and foam gaskets.
- 2.2.2 Door: Double-wall, galvanized sheet metal construction with insulation fill and thickness, number of hinges and locks as indicated for duct pressure class. Provide vision panel where indicated. Provide 1-inch by 1-inch (25-mm by 25-mm) butt hinge or piano hinge and cam latches.
- 2.2.3 Seal around frame attachment to duct and door to frame with neoprene or foam rubber seals.
- 2.2.4 Insulation: 1-inch- (25-mm-) thick fiber glass or polystyrene foam board.

**FLEXIBLE CONNECTORS:**

- 2.3.1 General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL Standard 181, Class 1.
- 2.3.2 Standard Metal-Edged Connectors: Factory-fabricated with a strip of fabric 3-1/2 inches (89 mm) wide attached to 2 strips of 2-3/4-inch-wide (70-mm-wide), 24-gage (0.7-mm), galvanized sheet steel or 0.032-inch (0.8-mm) aluminum sheets. Select metal compatible with connected duct system. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA HVAC Duct Standard, 1st Edition, Figure 2-19.
- 2.3.3 Conventional, Outdoor System Flexible Connectors  
Fabric: Glass fabric double coated with Du Pont's HYPALON or other synthetic-rubber weatherproof coating resistant to the sun's ultraviolet rays and ozone environment.
- 2.3.3.1 Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
- 2.3.3.2 Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.

#### ACCESSORIES HARDWARE:

- 1 Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket and a flat mounting gasket. Size to allow insertion of pitot tube and other testing instruments and provide in length to suit duct insulation thickness.
- 2.4.2 Splitter Damper Accessories: Zinc-plated damper blade bracket, 1/4-inch (6-mm), zinc-plated operating rod, and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.
- 2.4.3 Flexible Duct Clamps: Stainless steel band with cadmium-plated hex screw to tighten band with a worm-gear action. Provide in sizes from 3 to 18 inches (75 to 450 mm) to suit duct size.
- 2.4.4 Adhesives: High strength, quick setting, neoprene based, waterproof and resistant to gasoline and grease.

#### PART 3. EXECUTION

##### EXAMINATION:

- 3.1.1 Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of duct accessories. Do not proceed with installation until unsatisfactory conditions are corrected.

##### 3.2 INSTALLATION:

- 1 Install duct accessories according to manufacturer's installation instructions and applicable portions of details of construction as shown in SMACNA standards
- 3.2.2 Provide test holes at fan inlet and outlet and elsewhere as indicated.

##### ADJUSTING:

- 1 Adjust duct accessories for proper settings.

END OF SECTION 15910

## SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS

### PART 1. GENERAL

#### 1.1 SUMMARY:

- 1.1.1 This Section includes the following electrical materials and methods:
  - 1.1.1.1 Building wire, connectors, and splices for branch circuits and feeders.
  - 1.1.1.2 Supporting devices for electrical components
  - 1.1.1.3 Electrical identification.
  - 1.1.1.4 Electrical demolition.
  - 1.1.1.5 Cutting and patching for electrical construction
  - 1.1.1.6 Touchup painting.

#### SUBMITTALS:

- 1.2.1 General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- 1.2.2 Product Data for each type of product specified.

#### QUALITY ASSURANCE:

- 1.3.1 Comply with NFPA 70 for components and installation.
- 1.3.2 Listing and Labeling: Provide products specified in this Section that are listed and labeled.
  - 1.3.2.1 The Terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.
  - 1.3.2.2 Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

#### 1.4 SEQUENCING AND SCHEDULING:

- 1.4.1 Coordinate electrical equipment installation with other building components.

- 1.4.2 Coordinate connecting electrical service to components furnished under other Sections.
- 1.4.3 Coordinate installing electrical identification after completion of finishing where identification is applied to field-finished surfaces.
- 1.4.4 Coordinate installing electrical identifying devices and markings prior to installing finishes that conceal such items.

## **PART 2. PRODUCTS**

### **2.1 SUPPORTING DEVICES:**

- 2.1.1 Channel and angle support systems, hangers, anchors, sleeves, brackets, fabricated items, and fasteners are designed to provide secure support from the building structure for electrical components.
  - 2.1.1.1 Material: Steel, except as otherwise indicated, protected from corrosion with zinc coating or with treatment of equivalent corrosion resistance using approved alternative finish or inherent material characteristics.
  - 2.1.1.2 Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel, except as otherwise indicated.
- 2.1.2 Steel channel supports have 9/16-inch (14-mm) diameter holes at a maximum of 8 inches (203 mm) o.c., in at least 1 surface.
  - 2.1.2.1 Fittings and accessories mate and match with channels and are from the same manufacturer.
- 2.1.3 Nonmetallic Channel and Angle Systems: Structural-grade, factory-formed, fiberglass-resin channels and angles with 9/16-inch (14-mm) diameter holes at a maximum of 8 inches (203 mm) o.c., in at least 1 surface.
  - 2.1.3.1 Fittings and accessories mate and match with channels or angles and are from the same manufacturer.
  - 2.1.3.2 Fitting and Accessory Material: Same as channels and angles, except metal items may be stainless steel.

- 2.1.4 Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps or "click"- type hangers.
- 2.1.5 Sheet-Metal Sleeves: 0.0276-inch (0.7-mm) or heavier galvanized sheet steel, round tube, closed with welded longitudinal joint.
- 2.1.6 Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- 2.1.7 Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable iron casting with hot-dip galvanized finish.
- 2.1.8 Expansion Anchors: Carbon-steel wedge or sleeve type.
- 2.1.9 Toggle Bolts: All-steel springhead type.
- 2.1.10 Powder-Driven Threaded Studs: Heat-treated steel
- 2.2 **ELECTRICAL IDENTIFICATION:**
- 2.2.1 Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- 2.2.2 Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters
- 2.2.3 Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.
- 2.2.4 Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched for mechanical fasteners 1/16-inch (1.6-mm) minimum thick for signs up to 20 sq. in. (129 sq. cm), 1/8 inch (3.2 mm) thick for larger sizes. Engraved legend in black letters on white face.

- 2.2.5 Interior Warning and Caution Signs: Preprinted, aluminum, baked-enamel finish signs, punched for fasteners, with colors, legend, and size appropriate to the application.
- 2.2.6 Exterior Warning and Caution Signs: Weather-resistant, nonfading, preprinted, cellulose acetate butyrate signs with 0.0396-inch (1-mm), galvanized steel backing, with colors, legend, and size appropriate to the application. 1/4-inch (6.4-mm) grommets in corners for mounting.
- 2.2.7 Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.
- 2.3 **TOUCHUP PAINT:**
- 2.3.1 For Equipment: Provided by equipment manufacturer and selected to match equipment finish.
- 2.3.2 For Nonequipment Surfaces: Matching type and color undamaged, existing adjacent finish.
- 2.3.3 For Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

### **PART 3. EXECUTION**

- 3.1 **EQUIPMENT INSTALLATION REQUIREMENTS:**
- 3.1.1 Install components and equipment to provide the maximum possible headroom where mounting heights or other location criteria are not indicated.
- 3.1.2 Install items level, plumb, and parallel and perpendicular to other building systems and components, except where otherwise indicated.
- 3.1.3 Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- 3.1.4 Give right of way to raceways and piping systems installed at a required slope.

- 3.2        **ELECTRICAL SUPPORTING METHODS:**
- 3.2.1     Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components
- 3.2.2     Dry Locations: Steel materials
- 3.2.3     Conform to manufacturer's recommendations for selecting supports.
- 3.2.4     Strength of Supports: Adequate to carry all present and future loads, times a safety factor of at least 4; 200-lb- (90-kg-) minimum design load.
- 3.3        **INSTALLATION:**
- 3.3.1     Install wires in raceway according to manufacturer's written instructions and NECA's "Standard of Installation."
- 3.3.2     Conductor Splices: Keep to the minimum and comply the following:
  - 3.3.2.1   Install splices and taps that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
  - 3.3.2.2   Use splice and tap connectors that are compatible with conductor material.
- 3.3.3     Connect components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.
- 3.3.4     Install devices to securely and permanently fasten support electrical components.
- 3.3.5     Raceway Supports: Comply with NFPA 70 and the following requirements:
  - 3.3.5.1   Conform to manufacturer's recommendations for selecting and installing supports.

- 3.3.5.2 Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
- 3.3.5.3 Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- 3.3.5.4 Spare Capacity: Size supports for multiple conduits so capacity can be increased by a 25 percent minimum in the future.
- 3.3.5.5 Support individual horizontal raceways with separate malleable iron pipe hangers or clamps.
- 3.3.5.6 Hanger Rods: 1/4-inch (6-mm) diameter or larger threaded steel, except as otherwise indicated.
- 3.3.5.7 Spring Steel Fasteners: Specifically designed for supporting single conduits or tubing. May be used in lieu of malleable iron hangers for 1-1/2-inch (38-mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to channel and slotted angle supports.
- 3.3.5.8 In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
- 3.3.6 Vertical Conductor Supports: Install simultaneously with conductors.
- 3.3.7 Miscellaneous Supports: Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices except where components are mounted directly to structural features of adequate strength.

- 3.3.8 In open overhead spaces, cast boxes threaded to raceways need not be separately supported, except where used for fixture support; support sheet-metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches (610 mm) from the box.
- 3.3.9 Sleeves: Install for cable and raceway penetrations of concrete slabs and walls, except where core-drilled holes are used. Install for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- 3.3.10 Firestopping: Apply to cable and raceway penetrations of fire-rated floor and wall assemblies. Perform firestopping as specified in Division 7 Section "Firestopping" to reestablish the original fire-resistance rating of the assembly at the penetration.
- 3.3.11 Fastening: Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure. Perform fastening according to the following:
- 3.3.11.1 Fasten by means of wood screws or screw-type nails on wood; toggle bolts on hollow masonry units; concrete inserts or expansion bolts on concrete or solid masonry; and by machine screws, welded threaded studs, or spring-tension clamps on steel.
- 3.3.11.2 Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts, machine screws, or wood screws.
- 3.3.11.3 Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or any other items.
- 3.3.11.4 In partitions of light steel construction use sheet-metal screws.
- 3.3.11.5 Drill holes in concrete beams so holes more than 1-1/2 inches (38 mm) deep do not cut main reinforcing bars.

- 3.3.11.6 Drill holes in concrete so holes more than 3/4 inch (19 mm) deep do not cut main reinforcing bars.
- 3.3.11.7 Fill and seal holes drilled in concrete and not used.
- 3.3.11.8 Select fasteners so the load applied to any fastener does not exceed 25 percent of the proof-test load.
- 3.3.12 Install identification devices where required
  - 3.3.12.1 Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
  - 3.3.12.2 Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated on the Contract Documents or required by codes and standards. Use consistent designations throughout the Project.
  - 3.3.12.3 Self-Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.
  - 3.3.12.4 For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

**DEMOLITION:**

- 1 Where electrical work to remain is damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- 2 Accessible Work Indicated to Be Demolished: Remove exposed electrical installation in its entirety.
- 3.4.3 Removal: Remove demolished material from the Project site.
- 3.4.4 Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

CUTTING AND PATCHING:

- 1 Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for electrical installations. Perform cutting by skilled mechanics of the trades involved.
- 3.5.2 Repair disturbed surfaces to match adjacent undisturbed surfaces.

TOUCHUP PAINTING:

- 3.6.1 Thoroughly clean damaged areas and provide primer, intermediate, and finish coats to suit the degree of damage at each location.
- 3.6.2 Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

END OF SECTION 16050

## SECTION 16120 - CONDUCTORS AND CABLES

### PART 1. GENERAL

#### SUMMARY:

- 1.1.1 This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

#### SUBMITTALS:

- 1.2.1 Product Data for conductors and cables

#### 1.3 QUALITY ASSURANCE:

- 1.3.1 Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled.

- 1.3.1.1 The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.

- 1.3.1.2 Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

- 1.3.2 Comply with NFPA 70

#### DELIVERY, STORAGE, AND HANDLING:

- 1.4.1 Deliver wires and cables according to NEMA WC 26

#### 1.5 COORDINATION:

- 1.5.1 Coordinate layout and installation of cables with other installations.

- 1.5.2 Revise locations and elevations from those indicated, as required to suit field conditions and as approved by Architect.

### PART 2. PRODUCTS

#### 2.1 BUILDING WIRES AND CABLES:

- 2.1.1 UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3 "Wire and Insulation Applications" Article.

- 2.1.2 Rubber Insulation Material: Comply with NEMA WC 3.
- 2.1.3 Thermoplastic Insulation Material: Comply with NEMA WC 5.
- 2.1.4 Cross-Linked Polyethylene Insulation Material: Comply with NEMA WC 7.
- 2.1.5 Ethylene Propylene Rubber Insulation Material: Comply with NEMA WC 8.
- 2.1.6 Conductor Material: Copper.
- 2.1.7 Stranding: Solid conductor for No. 10 AWG and smaller; stranded conductor for larger than No. 10 AWG.
- 2.2 **CONNECTORS AND SPLICES:**
- 2.2.1 UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated. Comply with Project's installation requirements and as specified in Part 3 "Wire and Insulation Applications" Article.

### **PART 3. EXECUTION**

#### **EXAMINATION:**

- 3.1.1 Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

#### **WIRE AND INSULATION APPLICATIONS:**

- 3.2.1 Feeders: Type THHN/THWN, in raceway.
- 3.2.2 Branch Circuits: Type THHN/THWN, in raceway.
- 3.2.3 Class 1 Control Circuits: Type THHN/THWN, in raceway
- 3.2.4 Class 2 Control Circuits: Type THHN/THWN, in raceway

3.3        INSTALLATION:

- 3.3.1        Install wires and cables as indicated, according to manufacturer's written instructions and NECA's "Standard of Installation."
- 3.3.2        Remove existing wires from raceway before pulling in new wires and cables.
- 3.3.3        Pull Conductors: Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- 3.3.4        Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- 3.3.5        Identify wires and cables according to Division 16 Section "Basic Electrical Materials and Methods."
- 3.3.6        Identify wires and cables according to Division 16 Section "Electrical Identification."

CONNECTIONS:

- 1            Conductor Splices: Keep to minimum
- 2            Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
- 3            Use splice and tap connectors compatible with conductor material.
- 3.4.4        Use oxide inhibitor in each splice and tap connector for aluminum conductors.
- 3.4.5        Connect components to wiring and to ground as indicated and instructed by manufacturer.
- 3.4.6        Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

FIELD QUALITY CONTROL:

- 1      Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
- 3.5.1.1      Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS Section 7.3.1. Certify compliance with test parameters.
- 3.5.2      Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

END OF SECTION 16120

## SECTION 16130 - RACEWAYS AND BOXES

### PART 1. GENERAL

#### SUMMARY:

1.1.1 This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.1 Raceways include the following:

1.1.1.1 RMC

1.1.1.1.2

1.1.1.1.3 PVC externally coated, rigid steel conduits

1.1.1.1.4 PVC externally coated, IMC.

1.1.1.1.5

1.1.1.1.6 FMC

1.1.1.1.7 LFMC.

1.1.1.1.8 Wireways.

1.1.1.1.9 Surface raceways.

1.1.1.2 Boxes, enclosures, and cabinets include the following

1.1.1.2.1 Device boxes

1.1.1.2.2 Outlet boxes

1.1.1.2.3 Pull and junction boxes

1.1.1.2.4 Cabinets and hinged-cover enclosures.

1.1.2 Related Sections include the following:

1.1.2.1 Division 16 Section "Basic Electrical Materials and Methods" for raceways and box supports.

#### 1.2 DEFINITIONS:

1.2.1 EMT: Electrical metallic tubing.

1.2.2 FMC: Flexible metal conduit

RF

## SUBMITTALS

## QUALITY ASSURANCE

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## PART 2. PRODUCTS

### METAL CONDUIT AND TUBING

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- 2.1.6 EMT and Fittings ANSI C80.3.
- 2.1.6.1 Fittings: Compression type
- 2.1.7 FMC Zinc-coated steel
- 2.1.8 LFMC: Flexible steel conduit with PVC jacket
- 2.1.9 Fittings: NEMA FB 1; compatible with conduit/tubing materials.
- 2.2 **METAL WIREWAYS:**
  - 2.2.1 Material Sheet metal sized and shaped as indicated.
  - 2.2.2 Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
  - 2.2.3 Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
  - 2.2.4 Wireway Covers: Screw-cover type
  - 2.2.5 Finish: Manufacturer's standard enamel finish
- 2.3 **SURFACE RACEWAYS:**
  - 2.3.1 Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.
- 2.4 **OUTLET AND DEVICE BOXES:**
  - 2.4.1 Sheet Metal Boxes: NEMA OS 1.
  - 2.4.2 Cast-Metal Boxes: NEMA FB 1, Type FD, cast box with gasketed cover.
- 2.5 **PULL AND JUNCTION BOXES:**
  - 2.5.1 Small Sheet Metal Boxes: NEMA OS 1.
  - 2.5.2 Cast-Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover.

### ENCLOSURES AND CABINETS:

- 2.6.1 Hinged-Cover Enclosures: NEMA 250, Type 1 with continuous hinge cover and flush latch.
- 2.6.1.1 Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- 2 Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

### PART 3. EXECUTION

#### 3.1 EXAMINATION:

- 3.1.1 Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

#### 3.2 WIRING METHODS:

- 3.2.1 Outdoors: Use the following wiring methods:
  - 3.2.1.1 Exposed: Rigid steel or IMC
  - 1.2 Concealed: Rigid steel or IMC
  - 3.2.1.3 Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  - 1.4 Boxes and Enclosures NEMA 250, Type 3R or Type 4.
  - 2 Indoors: Use the following wiring methods
- 3.2.2.1 Exposed: EMT
- 3.2.2.2 Concealed: EMT

- 3.2.2.3 Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except in wet or damp locations, use LFMC.
- 3.2.2.4 Damp or Wet Locations: Rigid steel conduit
- 3.2.2.5 Boxes and Enclosures: NEMA 250 Type 1, except as follows:
  - 3.2.2.5.1 Damp or Wet Locations: NEMA 250, Type 4, stainless steel.
- 3.3 **INSTALLATION:**
  - 3.3.1 Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.
  - 3.3.2 Minimum Raceway Size: 3/4-inch trade size (DN21).
  - 3.3.3 Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors.
  - 3.3.4 Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
  - 3.3.5 Install raceways level and square and at proper elevations. Provide adequate headroom.
  - 3.3.6 Complete raceway installation before starting conductor installation.
  - 3.3.7 Support raceways as specified in Division 16 Section "Basic Electrical Materials and Methods."
  - 3.3.8 Use temporary closures to prevent foreign matter from entering raceways.
  - 3.3.9 Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
  - 3.3.10 Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.

- 3.3.11 Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.
- 3.3.12 Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.
- 3.3.13 Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.
  - 3.3.13.1 Run parallel or banked raceways together, on common supports where practical.
  - 3.3.13.2 Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- 3.3.14 Join raceways with fittings designed and approved for the purpose and make joints tight.
  - 3.3.14.1 Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
  - 3.3.14.2 Use insulating bushings to protect conductors
- 3.3.15 Tighten set screws of threadless fittings with suitable tools.
- 3.3.16 Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box.
- 3.3.17 Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.

- 3.3.18 Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of the pull wire.
- 3.3.19 Install raceway sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
  - 3.3.19.1 Where conduits pass from warm to cold locations, such as the boundaries of refrigerated spaces.
  - 3.3.19.2 Where otherwise required by NFPA 70
- 3.3.20 Flexible Connections: Use maximum of 6 feet (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.
- 3.3.21 Do not install aluminum conduits embedded in or in contact with concrete.
- 3.3.22 PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.
- 3.3.23 Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying the raceways to receptacle or fixture ground terminals.
  - 3.3.23.1 Select each surface raceway outlet box, to which a lighting fixture is attached, of sufficient diameter to provide a seat for the fixture canopy.
- 3.3.24 Install hinged-cover enclosures and cabinets plumb. Support at each corner.

3.4        PROTECTION:

3.4.1       Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.

3.4.1.1     Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

3.4.1.2     Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.5        CLEANING:

3.5.1       On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 16130

## SECTION 16452 - GROUNDING

### PART 1. GENERAL

#### SUMMARY

This Section includes grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other Sections of these Specifications.

- 1.1.2 Related Sections: The following Sections contain requirements that relate to this Section:

- 2.1 Division 16 Section "Wires and Cables" for requirements for grounding conductors.

#### SUBMITTALS:

- 2.1 Product Data for grounding rods, connectors and connection materials, and grounding fittings.

#### QUALITY ASSURANCE:

- 1.3.1 Comply with NFPA 70
- 1.3.2 Comply with UL 467.
- 1.3.3 Listing and Labeling: Provide products specified in this Section that are listed and labeled.
- 3.3.1 The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
- 1.3.3.2 Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

### PART 2. PRODUCTS

#### 2.1 GROUNDING AND BONDING PRODUCTS:

- 2.1.1 Governing Requirements: Where types, sizes, ratings, and quantities indicated are in excess of National Electrical Code (NEC) requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

- 2.2        WIRE AND CABLE GROUNDING CONDUCTORS:
- 2.2.1     Comply with Division 16 Section "Wires and Cables."  
Conform to NEC Table 8, except as otherwise indicated,  
for conductor properties, including stranding.
- 2.2.1.1   Material: Copper. Use only copper wire for both  
insulated and bare grounding conductors in direct  
contact with earth, concrete, masonry, crushed stone,  
and similar materials.
- 2.2.2     Equipment Grounding Conductors: Insulated with green  
color insulation.
- 3        Bare Copper Conductors: Conform to the following:
- 2.2.3.1   Solid Conductors: ASTM B 3.
- 2.2.3.2   Assembly of Stranded Conductors: ASTM B 8
- 2.2.3.3   Tinned Conductors: ASTM B 33
- 2.3       MISCELLANEOUS CONDUCTORS:
- 2.3.1     Grounding Bus: Bare, annealed-copper bars of  
rectangular cross section.
- 3.2       Braided Bonding Jumpers: Copper tape, braided  
No. 30 AWG bare copper wire, terminated with copper  
ferrules.
- 2.3.3     Bonding Straps: Soft copper, 0.05 inch (1 mm) thick  
and 2 inches (50 mm) wide, except as indicated
- 2.4       CONNECTOR PRODUCTS:
- 2.4.1     Pressure Connectors: High-conductivity-plated units
- 2.4.2     Bolted Clamps: Heavy-duty type

### PART 3. EXECUTION

- 3.1       APPLICATION:
- 3.1.1     Equipment Grounding Conductors: Comply with NEC  
Article 250 for types, sizes, and quantities of  
equipment grounding conductors, except where specific  
types, larger sizes, or more conductors than required  
by NEC are indicated.

3.1.1.1 Install equipment grounding conductor with circuit conductors for the items below in addition to those required by Code:

3.1.1.1.1 Feeders and branch circuits

3.1.1.1.2 Single-phase motor or appliance branch circuits

3.1.1.1.3 Three-phase motor or appliance branch circuits.

3.1.1.1.4 Flexible raceway runs

3.2 INSTALLATION:

3.2.1 General: Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.

3.2.2 Grounding Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

3.3 CONNECTIONS:

3.3.1 General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

3.3.1.1 Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.

3.3.1.2 Make connections with clean, bare metal at points of contact.

3.3.1.3 Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

3.3.1.4 Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.

3.3.1.5 Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

- 3.3.2 Equipment Grounding-Wire Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- 3.3.3 Noncontact Metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors, except as otherwise indicated.
- 3.3.4 Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.
- 3.3.5 Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- 3.3.6 Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.
- 3.4 ADJUSTING AND CLEANING:
- 3.4.1 Restore surface features, including vegetation, at areas disturbed by work of this Section. Reestablish original grades, except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 2 Section "Landscaping." Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION 16452

## SECTION 16476 - DISCONNECT SWITCHES AND CIRCUIT BREAKERS

### PART 1. GENERAL

#### 1.1 SUMMARY:

1.1.1 This Section includes individually mounted switches and circuit breakers used for the following:

1.1.1.1 Feeder and equipment disconnect switches.

1.1.1.2 Feeder branch-circuit protection.

1.1.1.3 Motor disconnect switches

1.1.2 Related Sections: The following Sections contain requirements that relate to this Section:

#### SUBMITTALS:

1.2.1 Product Data for switches, circuit breakers, and accessories specified in this Section. Include the following:

1.2.1.1 Descriptive data and time-current curves.

1.2.1.2 Let-through current curves for circuit breakers with current-limiting characteristics.

#### QUALITY ASSURANCE:

1.3.1 Source Limitations: Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.

1.3.2 Comply with NFPA 70 for components and installation

1.3.3 Listing and Labeling: Provide disconnect switches and circuit breakers specified in this Section that are listed and labeled.

1.3.3.1 The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

1.3.3.2 Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

## PART 2. PRODUCTS

### 2.1 DISCONNECT SWITCHES:

- 2.1.1 Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle.
- 2.1.2 Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position.
- 2.1.3 Enclosure: NEMA KS 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.
  - 2.1.3.1 Outdoor Locations Type 3R
  - 2.1.3.2 Other Wet or Damp Indoor Locations: Type 4.

### 2 ENCLOSED CIRCUIT BREAKERS:

- 2.2.1 Enclosed, Molded-Case Circuit Breaker: NEMA AB 1, with lockable handle.
- 2.2.2 Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting rating to meet available fault current.
- 2.3 Application Listing: Appropriate for application, including switching fluorescent lighting loads or heating, air- conditioning, and refrigerating equipment.
- 2.2.4 Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.
- 2.2.5 Circuit Breakers, 400 A and Larger: Field-adjustable, short-time and continuous-current settings.
- 2.2.6 Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.
- 2.2.7 Current Limiters: Where indicated, integral fuse listed for circuit breaker.
- 2.2.8 Molded-Case Switch: Where indicated, molded-case circuit breaker without trip units.

- 9 Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
- 2.2.10 Accessories: As indicated
- 2.11 Enclosure: NEMA AB 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.
- 2.2.11.1 Outdoor Locations: Type 3R.
- 2.2.11.2 Other Wet or Damp Indoor Locations: Type 4

### **PART 3. EXECUTION**

#### **INSTALLATION:**

- 3.1.1 Install disconnect switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.
- 3.1.2 Install disconnect switches and circuit breakers level and plumb.
- 3 Install wiring between disconnect switches, circuit breakers, control, and indication devices.
- 3.1.4 Connect disconnect switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer.
- 3.1.4.1 Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- 1.5 Identify each disconnect switch and circuit breaker according to requirements specified in Division 16 Section "Basic Electrical Materials and Methods."
- 3.1.6 Identify each disconnect switch and circuit breaker according to requirements specified in Division 16 Section "Electrical Identification."

3.2        FIELD QUALITY CONTROL:

3.2.1      Testing: After installing disconnect switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

3.2.1.1    Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for disconnect switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

3.2.2      Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.3        ADJUSTING:

3.3.1      Set field-adjustable disconnect switches and circuit breaker trip ranges as indicated.

3.4        CLEANING:

3.4.1      After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION 16476

**SEYMOUR JOHNSON  
AIR FORCE BASE  
NORTH CAROLINA**

**Specifications  
FOR**

**DATE: 16 JUNE 00**

**PROJECT NO: VKAG 97-1108**

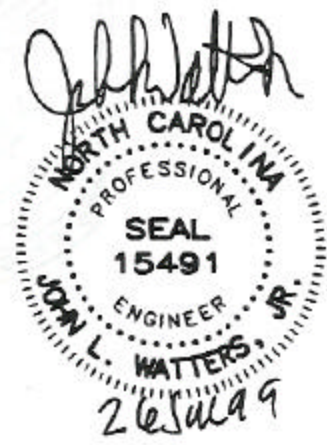
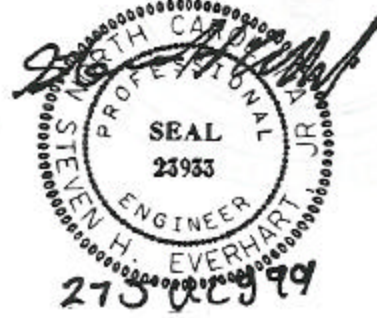
**PROJECT TITLE: REPAIR HVAC-2<sup>ND</sup> FLOOR WING HQ**

**PROJECT MANAGER: JEFFREY S. HOWARD**



SEYMOUR JOHNSON AIR FORCE BASE  
REPAIR HVAC  
2ND FLOOR WING HEADQUARTERS  
SEYMOUR JOHNSON AFB, NORTH CAROLINA  
(VKAG 97-1108)

HRA COMMISSION #140795.10



2ND FLOOR WING HEADQUARTERS  
(VKAG 97-1108)T A B L E     O F     C O N T E N T SDIVISION 1 - GENERAL DATA

01000            General

DIVISION 2 - SITEWORK

02051            Asbestos Removal, Cleanup, and Disposal  
02070            Selective Demolition  
02200            Earthwork  
02520            Portland Cement Concrete Paving

DIVISION 3 THRU 6 - NOT USEDDIVISION 7 - THERMAL AND MOISTURE PROTECTION

07901            Joint Sealants

DIVISION 8 - NOT USEDDIVISION 9 - FINISHES

09255            Gypsum Board Assemblies  
09511            Acoustical Panel Ceilings

DIVISION 10 THRU 14 - NOT USEDDIVISION 15 - MECHANICAL

15050            Basic Mechanical Materials and Methods  
15145            Hangers and Supports  
15250            Mechanical Insulation  
15510            Pipe and Pipe Fittings (Hydronic)  
15540            HVAC Pumps  
15683            Reciprocating Chillers  
15854            Central-Station Air-Handling Units  
15886            Air Filters  
15891            Metal Ductwork  
15910            Duct Accessories  
15932            Air Outlets and Inlets  
15933            Air Terminals  
15975            Control Systems Equipment  
15976            Variable Frequency Drive  
15990            Testing, Adjusting, and Balancing

DIVISION 16 - ELECTRICAL

16050            Basic Electrical Materials and Methods  
16120            Conductors and Cables  
16124            Medium-Voltage Cables  
16130            Raceways and Boxes

16140	Wiring Devices
16320	Medium Voltage Transformers
16341	Medium Voltage Pad Mounted Switchgear
16452	Grounding
16470	Panelboards
16475	Fuses
16476	Disconnect Switches and Circuit Breakers
16495	Transfer Switches
16621	Packaged Engine Generators

## **SECTION - 01000 GENERAL**

### **PART 1. GENERAL**

#### **1.1. SCOPE OF WORK:**

- 1.1.1. The work covered by this specification consists of furnishing all plant, labor, equipment and material, and performing all work in connection with Project VKAG 97-1108, "Repair HVAC 2nd Floor Wing Headquarters" in strict accordance with these specifications and drawings and subject to the terms and conditions of this contract.

#### **1.2 LOCATION:**

- 1.2.1 The work is to be accomplished at Seymour Johnson Air Force Base, Goldsboro, North Carolina. This base is accessible by both public highway and railway.

#### **1.3 WORKWEEK:**

- 1.3.1 The contractor shall observe the same regular workweek being observed by the Seymour Johnson AFB Civil Engineering shop forces, which is 7:30 a.m. to 4:30 p.m, Monday through Friday, with Federal holidays excluded. Any deviation from this schedule will require 48 hours advance notice and approval of the Contracting Officer.
- 1.3.2 The contractor shall accomplish some work after normal hours and on weekends (see constraints, this section) for the convenience of the Government at no additional cost to the Government.

#### **1.4 PRINCIPLE FEATURES:**

- 1.4.1 The work covered by this contract includes, but is not limited to the following:
  - 1.4.1.1 Base Bid:
    - 1.4.1.1.1 Building 2902, Wing Headquarters: Provide new second floor mechanical system and associated electrical, ceiling and site work, and provide pad mounted transformers to replace existing pole mounted transformers.
  - 1.4.1.2 Bid Option No. 1:
    - 1.4.1.2.1 Building 2902, Wing Headquarters: Provide emergency generator.
  - 1.4.1.3 Bid Option No. 2:
    - 1.4.1.3.1 Building 2902, Wing Headquarters: Provide additional primary power feed.

#### **1.5 HAUL ROUTES:**

- 1.5.1 The Contractor shall use the haul routes indicated on the plans.

- 1.6        **DISPOSITION OF NONSALVABLE MATERIALS:**
- 1.6.1      All nonsalvable or unusable material shall be disposed of off base as directed by the Contracting Officer. All waste material generated by any work under this contract shall be handled, transported, stored and disposed of off base, by the Contractor, in accordance with all applicable federal, state, or local laws, ordinances, regulations, court orders, or other types of rules or rulings having the effect of law.
- 1.7        **DISPOSITION OF SALVAGEABLE MATERIALS:**
- 1.7.1      Any salvable or reusable material will be identified by the contracting officer's representative. The contractor shall deliver all salvable/reusable material to a site on Base as directed by the Contracting Officer.
- 1.8        **SUBMITTALS REQUIRED:**
- 1.8.1      Required submittals are listed on AF Form 66.
- 1.9        **BASE CIVIL ENGINEERING WORK CLEARANCE REQUEST, AF FORM: 103**
- 1.9.1      The Contractor shall obtain AF Form 103, Base Civil Engineering Work Clearance Request, prior to work commencement from the Contract Management Section in Bldg 3300.
- 1.9.1.1    Upon receipt of an AF Form 103, the Contractor shall be responsible for locating all base owned underground utilities, as well as coordinating local utility companies to stake out utilities if not owned by the Base. By request, historical drawings, as-built drawings, and topographic drawings are available for review at the 4th Civil Engineer Squadron, Design Element located in Building 3300. Base owned utilities include but are not limited to electric, water, sewer, steam, communication, telephone, fiber optic, cathodic protection and fuel lines. Utilities not owned by the Base include but are not limited to cable TV, Southern Bell Telephone, and Natural Gas. The Contractor shall contact ULOCO and the non-base utility companies for location services. In the event that the Contractor damages a utility which is documented in the plans, record drawings, or located by a utility locator, the Contractor shall repair/replace the utility at no additional cost to the Government. Utilities not documented, shown, or located by a locator shall be considered abandoned or unknown. Contractor damage to unknown or abandoned utilities shall be dealt with as a differing site condition.
- 1.10       **SAFETY:**
- 1.10.1     All safety requirements of the U.S. Army Corps of Engineers Safety Manual 385-1-1 will be strictly adhered to as related to all work covered under these specifications.
- 1.11       **MATERIALS CONTAINING ASBESTOS:**

1.11.1 In the event the Contractor discovers materials suspected of containing asbestos that is not identified to be removed in the plans and specification, the Contractor shall notify the Contracting Officer. The Contractor's work shall proceed unless the materials suspected of containing asbestos are damaged or disturbed. Any suspected materials damaged or disturbed by the Contractor without permission from the Contracting Officer shall be removed by the Contractor at his expense IAW all applicable Federal, State, and local laws, or ordinances, regulations, court orders, or other types of rules or rulings having the effect of law.

1.12 **LABELING OF STORAGE DRUMS:**

1.12.1 All 55 gallon or larger drums brought on base for use under this contract and containing new material or used for storage of waste materials or hazardous waste must be labeled with a Department of Transportation (DOT) Proper Shipping Name, DOT Hazardous Identification Number, the Contractor's name, a Contractor representative, and the Contractor's telephone number. Label lettering should have a minimum height of one half inch painted in white paint or other color that is in contrast with the color of the drum. The label should be sufficiently durable to equal or exceed the life (including storage and disposal) of the drum.

1.13 **CONTRACTOR STORAGE TRAILER(S) AND BUILDING(S):**

1.13.1 The Contractor shall place or paint a sign on all of his storage trailer(s) and building(s) used on this contract. At a minimum, the sign shall contain the name of the Contractor and a telephone number at which the Contractor can be reached. The trailer(s) and building(s) shall be complete with gates and/or doors which can be locked. Only material for this project shall be stored in the trailer(s) or building(s). The Contractor shall remove the storage trailer(s) or building(s) within 30 days after completion of the contract and prior to submitting his final invoice. The area around the storage trailer(s) and building(s) shall be kept clean. This includes the mowing of grass during the growing season. The lawn mower shall be supplied by the Contractor.

1.13.2 The Contractor will be given a lot in the Contractor Storage Area behind Building 2700 for the life of the contract. The Contractor's progress schedule shall include a line item (equal to 1%) for final cleanup of this storage lot. Final payment will not be made until final cleanup is performed by the Contractor and accepted by the Contracting Officer.

1.14 **CONSTRAINTS:**

1.14.1 Repair existing systems and finishes damaged by construction operations.

1.14.2 Store no combustible materials in the building.

1.14.3 Contractor shall store all materials, equipment, scaffolding,

etc. in contractor storage area as shown on plans.

- 1.14.4 Contractor shall protect all existing vegetation not indicated to be removed during construction. Any damaged vegetation/landscaping resulting from contractor's activities shall be replaced at no additional cost to the Government.
- 1.14.5 Park construction vehicles only in locations designated by the Government.
- 1.14.6 Maintain clear path of travel on all roadways, driveway, and walkways.
- 1.14.7 Provide a temporary construction fence barricade around all trenching and open excavation activities.
- 1.14.8 Maintain site clean and clear of all waste construction materials. Remove debris daily to off-base disposal area.
- 1.14.9 Remove debris at the end of each work day.
- 1.14.10 Main Conference 216 and Projection 214 will be occupied by government personnel and shall remain operational during the construction period. All other second floor spaces will be vacated by personnel during the construction period. Furnishings will remain in place and shall be protected. Contractor access to main Conference 216 and Projection 217 shall be at the convenience of the government as scheduled with the Contracting Officer's Representative.
- 1.14.11 All utility shut-downs shall be scheduled and coordinated with the Contracting Officer representative. Requests for shut-down shall be discussed two weeks ahead of the anticipated date. Formal request shall be made a minimum 48 hours prior to the requested date. Requests will be accommodated at the convenience of the Government.
  - 1.14.11.1 Request for a shut-down shall include a realistic forecasted duration. Duration shall be minimized.
  - 1.14.11.2 Contractor shall accomplish work involving shut-downs on weekends or nights at no additional cost to the Government.
- 1.14.12 Maintain clear path of egress in all corridors and stairs.
  - 1.14.12.1 Any work which requires blockage of corridors or stairs shall be accomplished during hours when the building is not occupied. This work shall be coordinated and approved by the Contracting Officer's representative.
- 1.14.13 Provide dust barriers as required to prevent contamination of adjacent areas due to construction operations.
- 1.15 **PHASING:**
  - 1.15.1 Phase I: The first 90 calendar days of the contract shall be

limited to submittal approval and equipment ordering and delivery.

1.15.1.1 No site work shall occur during this phase.

1.15.2 Phase II:

1.15.2.1 Base Bid:

The remaining 90 calendar days of the contract shall be utilized for on-site work. All equipment submitted shall be approved prior to on site work.

1.15.2.2 Bid Option No. 1:

Option work shall be accomplished within the Base Bid time frame.

1.15.2.3 Bid Option No. 2:

Option work shall be accomplished within the Base Bid time frame.

END OF SECTION - 01000

## **SECTION 02051 - ASBESTOS REMOVAL, CLEANUP, AND DISPOSAL**

### **PART 1 GENERAL**

#### **1.1 GENERAL:**

- 1.1.1 The term abate, as used in plans and specifications, shall mean to removed, clean up, and dispose of asbestos containing materials (ACM). The work covered by this section includes the removal, cleanup, and disposal of materials containing asbestos.

#### **2.1 DOCUMENTATION OF PERFORMANCE IN ASBESTOS REMOVAL:**

- 2.1.1 The Contractor shall furnish documentation of successful performance in asbestos removal. This documentation will include names and addresses of purchasers of services and location of work performed.
- 2.1.2 The Contractor shall have at all times in his possession at his office (one copy) and in view at the job site (one copy) OSHA Regulation 29 CFR 1926.58, Asbestos and Environmental Protection Agency 40 CFR, Part 61, Subpart B: National Emission Standard for Asbestos, Asbestos Stripping Work Practices, and Disposal of Asbestos Waste; N.C. General Statute 130A, Article 19, Asbestos Hazard Management.

#### **3.1 REGULATORY REQUIREMENTS:**

- 3.1.1 All asbestos removal, cleanup, and disposal shall be made in accordance with:
- 3.1.2 N.C. General Statute 130A, Article 19 and OSHA Regulation 1926.58 - Asbestos, permissible exposure limits for asbestos shall apply to all air samples:
- |         |             |                |
|---------|-------------|----------------|
| 3.1.2.1 | Amosite     | 0.01 fibers/cc |
| 3.1.2.2 | Chrysotile  | 0.01 fibers/cc |
| 3.1.2.3 | Crocidolite | 0.01 fibers/cc |
| 3.1.2.4 | All others  | 0.01 fibers/cc |
- 3.1.2 EPA 40 CFR, Part 61, Subpart B - National Emission Standard for Asbestos, Asbestos Stripping, Stripping Work Practice, and Disposal of Asbestos Waste.
- 3.1.3 Other State and Local Agency Requirements.

4.1

**SUBMITTALS:**

4.1.1

Pre-Removal Plan: Submit a detailed plan of the work procedures to be used in the removal and demolition of materials containing asbestos. The pre-removal plans must be approved and signed by an N.C. State accredited Asbestos Abatement Project Designer. Such plan shall include location of asbestos control areas, change rooms, layout of change rooms, interface of trades involved in the construction, sequencing of asbestos related work, disposal plan, type of wetting agent and asbestos sealer to be used, air monitoring, and a detailed description of the method to be employed in order to control pollution. Provide copies of all notifications sent to agencies. This plan must be approved prior to the start of any asbestos work. Include North Carolina Asbestos Accreditation Certificates for each worker and Accredited Supervisor and Asbestos Removal Permits/Notifications when removal quantities required by N.C. Statute 130A, Article 19.

4.1.2

Submit personnel and space air monitoring and final clearance reports.

4.1.3

Training: Submit certificates signed by each employee that the employee has received current accredited training within 14 months of the scheduled removal work in the proper handling of materials that contain asbestos; understands the health implications and risks involved, including the illness possible from exposure to airborne asbestos fibers; understands the use and limits of the respiratory equipment to be used; and understands the results of monitoring of airborne quantities of asbestos as related to health and respiratory equipment.

4.1.4

Return manifest signed by company or landfill accepting custody of asbestos waste within 24 hours. Minimum information on the manifest shall include; date of disposal, quantity, sources of asbestos waste type of insulation (pipe, duct, etc.), name of certified/licensed asbestos removal contractor.

5.1

**REMOVAL, CLEANUP, AND PREPARATION:**

5.1.1

The Contractor shall have proper dress and equipment for all personnel. The Contractor shall provide proper decontamination facilities. The method of asbestos removal shall be conducted as required by regulation. Work areas shall be decontaminated prior to resuming other activities.

6.1        **PHASING AND SCOPE:**

6.1.1      Phasing of asbestos removal will be coordinated by the general Contractor and approved by the Contracting Officer.

7.1        **ASBESTOS TEST RESULTS:**

7.1.1      Asbestos Test Results are attached for information purposes only and cannot be guaranteed by the Government and Architect.

7.1.2      Results of inquiry accomplished by Base Abatement Shop personnel are as follows:

- 1st and 2nd floor gypsum board ceilings above lay-in acoustical tile ceilings - 5% chrysotile asbestos.
- 1st and 2nd floor wall joint compound - 5% chrysotile asbestos.
- 1st and 2nd floor tile and mastic - 8% chrysotile asbestos.
- 1st and 2nd floor mechanical room piping - 5% chrysotile asbestos.
- Duct insulation - fiberglass.

## **SECTION 02070 - SELECTIVE DEMOLITION**

### **PART 1. GENERAL**

#### 1.1. **SUMMARY:**

1.1.1. This Section includes the following:

1.1.1.1. Demolition and removal of selected portions of a building.

1.1.1.2. Demolition and removal of selected site elements.

1.1.1.3. Patching and repairs.

#### 1.2. **DEFINITIONS:**

1.2.1. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain the Government's property.

1.2.2. Remove and Reinstall: Remove items indicated; clean, service, and otherwise prepare them for reuse; store and protect against damage. Reinstall items in the same locations or in locations indicated.

1.2.3. Existing to Remain: Protect construction indicated to remain against damage and soiling during selective demolition.

#### 1.3. **MATERIALS OWNERSHIP:**

1.3.1. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain the Government's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option.

#### 1.4. **PROJECT CONDITIONS:**

1.4.1. Government will occupy portions of the building immediately adjacent to selective demolition area. Conduct selective demolition so that Government's operations will not be disrupted. Provide not less than 72 hours' notice to Contracting Officer's Representative of activities that will affect Government's operations.

1.4.2. Government assumes no responsibility for actual condition of buildings to be selectively demolished.

- 1.4.2.1. Conditions existing at time of inspection for bidding purpose will be maintained by Government as far as practical.
- 1.4.3. Asbestos: Asbestos is present in the building to be selectively demolished. A report on the presence of asbestos is on file for review and use. Examine the report to become aware of locations where asbestos is present.
  - 1.4.3.1. Asbestos abatement is specified elsewhere in the Contract Documents.
  - 1.4.3.2. Do not disturb asbestos or any material suspected of containing asbestos except under the procedures specified elsewhere in the Contract Documents.
- 1.4.4. Storage or sale of removed items or materials on-site will not be permitted.
- 1.5. **SCHEDULING:**
  - 1.5.1. Arrange selective demolition schedule so as not to interfere with Government's on-site operations except as previously agreed upon by the Government.

**PART 2. - PRODUCTS** (Not Applicable)

- 2.1. **REPAIR MATERIALS:**
  - 2.1.1. Use repair materials identical to existing materials.
    - 2.1.1.1. Where identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
    - 2.1.1.2. Use materials whose installed performance equals or surpasses that of existing materials.

**PART 3. EXECUTION**

- 3.1. **EXAMINATION:**
  - 3.1.1. Verify that utilities have been disconnected and capped.
  - 3.1.2. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
  - 3.1.3. Inventory and record the condition of items to be removed and reinstalled.

- 3.1.4. When unanticipated mechanical, electrical, or structural elements that conflict with the intended function or design are encountered, investigate and measure the nature and extent of the conflict. Promptly submit a written report to the Contract Officer's Representative.
- 3.1.5. Survey the condition of the building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of the structure or adjacent structures during selective demolition.
- 3.2. **UTILITY SERVICES:**
  - 3.2.1. Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
    - 3.2.1.1. Do not interrupt existing utilities serving occupied or operating facilities, except when authorized in writing by Government and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Government.
      - 3.2.1.1.1. Provide not less than 72 hours' notice to Government if shutdown of service is required during changeover.
- 3.3. **PREPARATION:**
  - 3.3.1. Conduct demolition operations and remove debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
    - 3.3.1.1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Government. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
  - 3.3.2. Conduct demolition operations to prevent injury to people and damage to adjacent buildings and facilities to remain. Ensure safe passage of people around selective demolition area.
    - 3.3.2.1. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required.
    - 3.3.2.2. Protect existing site improvements, appurtenances, and landscaping to remain.
    - 3.3.2.3. Provide temporary weather protection, during interval between demolition and removal of existing construction, on exterior

surfaces and new construction to ensure that no water leakage or damage occurs to structure or interior areas.

- 3.3.2.4. Protect walls, ceilings, floors, and other existing finish work that are to remain and are exposed during selective demolition operations.
- 3.3.2.5. Cover and protect furniture, furnishings, and equipment that have not been removed.
- 3.3.3. Erect and maintain dustproof partitions and/or temporary enclosures to limit dust and dirt migration.
  - 3.3.3.1. Construct temporary enclosures from fire-retardant tarpaulins.
  - 3.3.3.2. Seal joints and perimeter. Equip partitions with dustproof doors and security locks.
  - 3.3.3.3. Protect air-handling equipment.
  - 3.3.3.4. Weatherstrip openings.
- 3.3.4. Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of building to be selectively demolished.
  - 3.3.4.1. Strengthen or add new supports when required during progress of selective demolition.
- 3.4. **POLLUTION CONTROLS:**
  - 3.4.1. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
  - 3.4.2. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before start of selective demolition.
- 3.5. **SELECTIVE DEMOLITION:**
  - 3.5.1. Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete Work within limitations of governing regulations and as follows:
    - 3.5.1.1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. To minimize disturbance of adjacent surfaces, use hand or small power tools

designed for sawing or grinding, not hammering and chopping.  
Temporarily cover openings to remain.

- 3.5.1.2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
- 3.5.1.3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
- 3.5.1.4. Maintain adequate ventilation when using cutting torches.
- 3.5.1.5. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
- 3.5.1.6. Dispose of demolished items and materials promptly. On-site storage or sale of removed items is prohibited.
- 3.5.1.7. Return elements of construction and surfaces to remain to condition existing before start of selective demolition operations.
- 3.5.2. Demolish concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain, using power-driven masonry saw or hand tools; do not use power-driven impact tools.
- 3.5.3. Break up and remove concrete slabs on grade as indicated or as required..
- 3.6. **PATCHING AND REPAIRS:**
- 3.6.1. Promptly patch and repair holes and damaged surfaces caused to adjacent construction by selective demolition operations.
- 3.6.2. Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.
- 3.6.2.1. Completely fill holes and depressions in existing masonry walls to remain with an approved masonry patching material, applied according to manufacturer's printed recommendations.
- 3.6.3. Restore exposed finishes of patched areas and extend finish restoration into adjoining construction to remain in a manner that eliminates evidence of patching and refinishing.
- 3.6.4. Patch and repair floor and wall surfaces as required. Provide a

flush and even surface of uniform color and appearance.

- 3.6.4.1. Closely match texture and finish of existing adjacent surface.
- 3.6.4.2. Patch with durable seams that are as invisible as possible. Comply with specified tolerances.
- 3.6.4.3. Where patching smooth painted surfaces, extend final paint coat over entire unbroken surface containing the patch after the surface has received primer and second coat.
- 3.6.5. Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.
- 3.7. **DISPOSAL OF DEMOLISHED MATERIALS:**
  - 3.7.1. General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
  - 3.7.2. Burning: Do not burn demolished materials.
  - 3.7.3. Disposal: Transport demolished materials off Base property and legally dispose of them.
- 3.8. **CLEANING:**
  - 3.8.1. Sweep the building broom clean and vacuum on completion of selective demolition operation.

## **SECTION 02200 - EARTHWORK**

### **PART 1. GENERAL**

#### **1.1. SUMMARY**

- 1.1.1. This Section includes the following:
  - 1.1.1.1. Preparing and grading subgrades for slabs-on-grade, walks, pavements, and landscaping.
  - 1.1.1.2. Excavating and backfilling for underground mechanical and electrical utilities and appurtenances.

#### **1.2. DEFINITIONS**

- 1.2.1. Excavation consists of the removal of material encountered to subgrade elevations and the reuse or disposal of materials removed.
- 1.2.2. Subgrade: The uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- 1.2.3. Borrow: Soil material obtained off-site when sufficient approved soil material is not available from excavations.
- 1.2.4. Unauthorized excavation consists of removing materials beyond indicated subgrade elevations or dimensions without direction by the Government. Unauthorized excavation, as well as remedial work directed by the Government, shall be at the Contractor's expense.
- 1.2.5. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below ground surface.
- 1.2.6. Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within building lines.

#### **1.3. SUBMITTALS**

- 1.3.1. General: Submit the following according to the Conditions of the Contract.
- 1.3.2. Product data for the following:
  - 1.3.2.1. Each type of plastic warning tape.

1.4. **QUALITY ASSURANCE**

1.4.1. Codes and Standards: Perform earthwork complying with requirements of authorities having jurisdiction.

1.5. **PROJECT CONDITIONS**

1.5.1. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Government or others except when permitted in writing by the Government.

1.5.1.1. Provide a minimum 72-hours notice to the Government and receive written notice to proceed before interrupting any utility.

**PART 2. PRODUCTS**

2.1. **SOIL MATERIALS**

2.1.1. General: Provide approved borrow soil materials from off- site when sufficient approved soil materials are not available from excavations.

2.1.2. Satisfactory Soil Materials: ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, and SM; free of rock or gravel larger than 2 inches (50 mm) in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter.

2.1.3. Unsatisfactory Soil Materials: ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT.

2.1.4. Backfill and Fill Materials: Satisfactory soil materials.

2.1.5. Subbase and Base Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand, ASTM D 2940, with at least 95 percent passing a 1-1/2 inch (38 mm) sieve and not more than 8 percent passing a No. 200 (75 micrometer) sieve.

2.1.6. Bedding Material: Subbase or base materials with 100 percent passing a 1 inch (25 mm) sieve and not more than 8 percent passing a No. 200 (75 micrometer) sieve.

2.2. **ACCESSORIES**

2.2.1. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility. Tape shall include a metallic strip or a separate metallic tracer wire shall be provided.

2.2.1.1. Tape Colors: Provide tape colors to utilities as follows:

2.2.1.1.1. Red: Electric.

**PART 3. EXECUTION**

3.1. **PREPARATION**

3.1.1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

3.1.2. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

3.1.3. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.2. **DEWATERING**

3.2.1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

3.2.2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

3.3. **EXCAVATION**

3.3.1. Explosives: Do not use explosives.

3.3.2. Unclassified Excavation: Excavation is unclassified and includes excavation to required subgrade elevations regardless of the character of materials and obstructions encountered.

- 3.4. **STABILITY OF EXCAVATIONS**
- 3.4.1. Comply with local codes, ordinances, and requirements of authorities having jurisdiction to maintain stable excavations.
- 3.5. **EXCAVATION FOR UTILITY TRENCHES**
- 3.5.1. Excavate trenches to indicated slopes, lines, depths, and invert elevations.
- 3.5.1.1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- 3.5.2. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit, unless otherwise indicated.
- 3.5.2.1. Clearance: 12 inches (300 mm) each side of pipe or conduit.
- 3.5.3. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove stones and sharp objects to avoid point loading.
- 3.5.3.1. For pipes or conduit less than 6 inches (150 mm) in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
- 3.6. **STORAGE OF SOIL MATERIALS**
- 3.6.1. Stockpile excavated materials acceptable for backfill and fill soil materials, including acceptable borrow materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent wind-blown dust.
- 3.6.1.1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.
- 3.7. **BACKFILL**
- 3.7.1. Backfill excavations promptly, but not before completing the following:
- 3.7.1.1. Acceptance of construction below finish grade.
- 3.7.1.2. Surveying locations of underground utilities for record documents.
- 3.7.1.3. Testing, inspecting, and approval of underground utilities.
- 3.7.1.4. Removal of trash and debris from excavation.

- 3.7.1.5. Removal of temporary shoring and bracing, and sheeting.
- 3.8. **UTILITY TRENCH BACKFILL**
  - 3.8.1. Place and compact bedding course to fill unauthorized excavations. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
  - 3.8.2. Concrete backfill trenches that carry below or pass under footings and that are excavated within 18 inches (450 mm) of footings. Place concrete to level of bottom of footings.
  - 3.8.3. Place and compact initial backfill of satisfactory soil material or subbase material, free of particles larger than 1 inch (25 mm), to a height of 12 inches (300 mm) over the utility pipe or conduit.
    - 3.8.3.1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.
  - 3.8.4. Coordinate backfilling with utilities testing.
  - 3.8.5. Fill voids with approved backfill materials as shoring and bracing, and sheeting is removed.
  - 3.8.6. Place and compact final backfill of satisfactory soil material to final subgrade.
  - 3.8.7. Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.
- 3.9. **FILL**
  - 3.9.1. Preparation: Remove vegetation, topsoil, debris, wet, and unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placing fills.
    - 3.9.1.1. Plow strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing surface.
  - 3.9.2. When subgrade or existing ground surface to receive fill has a density less than that required for fill, break up ground surface to depth required, pulverize, moisture-condition or aerate soil and recompact to required density.
  - 3.9.3. Place fill material in layers to required elevations for each location listed below.
    - 3.9.3.1. Under grass, use satisfactory excavated or borrow soil material.

- 3.9.3.2. Under slab foundations and walks, use subbase or base material, or satisfactory excavated or borrow soil material.
- 3.10. **MOISTURE CONTROL**
  - 3.10.1. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.
    - 3.10.1.1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
    - 3.10.1.2. Remove and replace, or scarify and air-dry satisfactory soil material that is too wet to compact specified density.
      - 3.10.1.2.1. Stockpile or spread and dry removed wet satisfactory soil material.
- 3.11. **COMPACTION**
  - 3.11.1. Place backfill and fill materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.
  - 3.11.2. Place backfill and fill materials evenly on all sides of structures to required elevations. Place backfill and fill uniformly along the full length of each structure.
  - 3.11.3. Percentage of Maximum Dry Density Requirements: Compact soil to not less than the following percentages of maximum dry density according to ASTM D 1557:
    - 3.11.3.1. Under slab foundation, compact the top 12 inches (300 mm) below subgrade and each layer of backfill or fill material at 95 percent maximum dry density.
- 3.12. **GRADING**
  - 3.12.1. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
    - 3.12.1.1. Provide a smooth transition between existing adjacent grades and new grades.
    - 3.12.1.2. Cut out soft spots, fill low spots, and trim high spots to conform to required surface tolerances.
  - 3.12.2. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
- 3.13. **TOPSOIL**

- 3.13.1. Respread existing topsoil to a depth of 4-inches with top surface to align with finished grades.
- 3.14. **PROTECTION**
- 3.14.1. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- 3.14.2. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or lose compaction due to subsequent construction operations or weather conditions.
- 3.14.3. Settling: Where settling occurs during the Project correction period, remove finished surfacing, backfill with additional approved material, compact, and reconstruct surfacing.
- 3.14.3.1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.15. DISPOSAL OF SURPLUS AND WASTE MATERIALS

- 3.15.1. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off the Government property.

## **SECTION 02520 - PORTLAND CEMENT CONCRETE PAVING**

### **PART 1. GENERAL**

#### **1.1. SUMMARY:**

- 1.1.1. This Section includes exterior portland cement concrete paving for the following:
  - 1.1.1.1. Equipment pads.
  - 1.1.1.2. Walkways.
- 1.1.2. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1.1.2.1. Division 2 Section "Earthwork" for subgrade preparation, grading and subbase course.

#### **1.2. SUBMITTALS:**

- 1.2.1. General: Submit the following according to the Conditions of the Contract.
- 1.2.2. Batch ticket.

#### **1.3. QUALITY ASSURANCE:**

- 1.3.1. Concrete Standards: Comply with provisions of the following standards, except where more stringent requirements are indicated.
  - 1.3.1.1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
  - 1.3.1.2. ACI 318, "Building Code Requirements for Reinforced Concrete."
  - 1.3.1.3. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."
- 1.3.2. Concrete Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

### **PART 2. PRODUCTS**

#### **2.1. FORMS:**

- 2.1.1. Form Materials: Plywood, metal, metal-framed plywood, or other acceptable panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

2.1.2. Form Release Agent: Provide commercial formulation form- release agent with a maximum of 350 g/L volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.2. **REINFORCING MATERIALS:**

2.2.1. Welded Steel Wire Fabric: ASTM A 185.

2.2.1.1. Furnish in flat sheets, not rolls, unless otherwise acceptable to the Government.

2.2.2. Supports for Reinforcement: Chairs, spacers, dowel bar supports and other devices for spacing, supporting, and fastening reinforcing bars, welded wire fabric, and dowels in place. Use wire bar-type supports complying with CRSI specifications.

2.3. **CONCRETE MATERIALS:**

2.3.1. Portland Cement: ASTM C 150, Type I.

2.3.1.1. Use one brand of cement throughout Project unless otherwise acceptable to the Government.

2.3.2. Normal-Weight Aggregates: ASTM C 33, Class 4, and as follows. Provide aggregates from a single source.

2.3.2.1. Maximum Aggregate Size: 3/4-inches.

2.3.2.2. Do not use fine or coarse aggregates that contain substances that cause spalling.

2.3.3. Water: Potable.

2.4. **ADMIXTURES:**

2.4.1. Provide concrete admixtures that contain not more than 0.1 percent chloride ions.

2.4.2. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

2.4.3. Water-Reducing Admixture: ASTM C 494, Type A.

2.4.4. High-Range Water-Reducing Admixture: ASTM C 494, Type F or Type G.

2.4.5. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.

2.4.6. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

2.5. **CURING MATERIALS:**

- 2.5.1. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
- 2.5.2. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
  - 2.5.2.1. Waterproof paper.
  - 2.5.2.2. Polyethylene film.
  - 2.5.2.3. White burlap-polyethylene sheet.
- 2.5.3. Clear Solvent-Borne Liquid Membrane-Forming Curing Compound: ASTM C 309, Type I, Class A or B, wax free.
- 2.5.4. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type I, Class B.
  - 2.5.4.1. Provide material that has a maximum volatile organic compound (VOC) rating of 350 g/L.
- 2.5.5. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.
- 2.6. **RELATED MATERIALS:**
  - 2.6.1. Bonding Agent: Acrylic or styrene butadiene.
  - 2.6.2. Epoxy Adhesive: ASTM C 881, two-component material suitable for dry or damp surfaces. Provide material type, grade, and class to suit requirements.
- 2.7. **CONCRETE MIX:**
  - 2.7.1. Limit use of fly ash to zero percent of cement content by weight.
  - 2.7.2. Proportion mixes according to ACI 211.1 and ACI 301 to provide normal-weight concrete with the following properties:
    - 2.7.2.1. Compressive Strength (28-Day): 3000 psi.
    - 2.7.2.2. Maximum Water-Cement Ratio at Point of Placement: 0.46.
    - 2.7.2.3. Slump Limit at Point of Placement: 3 inches.
      - 2.7.2.3.1. Slump limit for concrete containing high-range water-reducing admixture (superplasticizer): Not more than 8 inches after adding admixture to site- verified 2-to-3-inch slump concrete.
  - 2.7.3. Add air-entraining admixture at manufacturer's prescribed rate to

result in concrete at point of placement having an air content as follows with a tolerance of plus or minus 1- 1/2 percent:

2.7.3.1. Air Content: 6.0 percent for 3/4-inch maximum aggregate.

2.8. **CONCRETE MIXING:**

2.8.1. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94.

2.8.1.1. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

2.9. **REINFORCING MATERIALS:**

2.9.1 Reinforcing Bars: ASTM A615, grade 60, deformed.

**PART 3. EXECUTION**

3.1. **SURFACE PREPARATION:**

3.1.1. Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.

3.1.2. Remove loose material from compacted subbase surface immediately before placing concrete.

3.2. **EDGE FORMS AND SCREED CONSTRUCTION:**

3.2.1. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for paving to required lines, grades, and elevations. Install forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement.

3.2.2. Check completed formwork and screeds for grade and alignment to following tolerances:

3.2.2.1. Top of Forms: Not more than 1/8 inch in 10 feet.

3.2.2.2. Vertical Face on Longitudinal Axis: Not more than 1/4 inch in 10 feet.

3.2.3. Clean forms after each use and coat with form release agent as required to ensure separation from concrete without damage.

3.3. **PLACING REINFORCEMENT:**

3.3.1. General: Comply with Concrete Reinforcing Steel Institute's

recommended practice for "Placing Reinforcing Bars" for placing and supporting reinforcement.

- 3.3.2. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- 3.3.3. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- 3.3.4. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.4. **JOINTS:**

- 3.4.1. General: Construct contraction, joints true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to the centerline, unless indicated otherwise.
- 3.4.2. Expansion Joints: Form isolation joints of preformed joint filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
  - 3.4.2.1. Locate expansion joints at intervals of 20 feet unless indicated otherwise.
  - 3.4.2.2. Extend joint fillers full width and depth of joint, not less than 1/2 inch or more than 1 inch below finished surface where joint sealant is indicated. Place top of joint filler flush with finished concrete surface when no joint sealant is required.
  - 3.4.2.3. Furnish joint fillers in one-piece lengths for full width being placed wherever possible. Where more than one length is required, lace or clip joint filler sections together.
  - 3.4.2.4. Protect top edge of joint filler during concrete placement with a metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

3.5. **CONCRETE PLACEMENT:**

- 3.5.1. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- 3.5.2. Remove snow, ice, or frost from subbase surface and reinforcing before placing concrete. Do not place concrete on surfaces that

are frozen.

- 3.5.3. Moistens subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.
- 3.5.4. Comply with requirements and with ACI 304R for measuring, mixing, transporting, and placing concrete.
- 3.5.5. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
  - 3.5.5.1. When concrete placing is interrupted for more than 1/2 hour, place a construction joint.
- 3.5.6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- 3.5.7. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete complying with ACI 309R.
  - 3.5.7.1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcing, dowels, and joint devices.
- 3.5.8. Screed concrete surfaces with a straightedge and strike off. Use bull floats or darbies to form a smooth surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces prior to beginning finishing operations.
- 3.5.9. Cold-Weather Placement: Comply with provisions of ACI 306R and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
  - 3.5.9.1. When air temperature has fallen to or is expected to fall below 40 deg F (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
  - 3.5.9.2. Do not use frozen materials or materials containing ice or snow.
  - 3.5.9.3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

- 3.5.10. Hot-Weather Placement: Place concrete complying with ACI 305R and as specified when hot weather conditions exist.
- 3.5.10.1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F (32 deg C). Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water.
- 3.5.10.2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
- 3.5.10.3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.6. **CONCRETE FINISHING:**

- 3.6.1. Float Finish: Begin floating when bleed water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Finish surfaces to true planes within a tolerance of 1/4 inch in 10 feet as determined by a 10-foot-long straightedge placed anywhere on the surface in any direction. Cut down high spots and fill low spots. Refloat surface immediately to a uniform granular texture.
- 3.6.1.1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across concrete surface perpendicular to line of traffic to provide a uniform fine line texture finish.
- 3.6.2. Final Tooling: Tool edges of paving, gutters, curbs, and joints formed in fresh concrete with a jointing tool to the following radius. Repeat tooling of edges and joints after applying surface finishes. Eliminate tool marks on concrete surfaces.
- 3.6.2.1. Radius: 1/4 inch.

3.7. **CONCRETE PROTECTION AND CURING:**

- 3.7.1. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with the recommendations of ACI 306R for cold weather protection and ACI 305R for hot weather protection during curing.
- 3.7.2. Evaporation Control: In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before floating.

- 3.7.3. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- 3.7.4. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
  - 3.7.4.1. Moisture Curing: Keep surfaces continuously moist for not less than 7 days with the following materials:
    - 3.7.4.1.1. Water.
    - 3.7.4.1.2. Continuous water-fog spray.
    - 3.7.4.1.3. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with a 12-inch lap over adjacent absorptive covers.
  - 3.7.4.2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
  - 3.7.4.3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
- 3.8. **REPAIRS AND PROTECTION:**
  - 3.8.1. Remove and replace concrete paving that is broken, damaged, or defective, or does not meet the requirements of this Section.
  - 3.8.2. Protect concrete from damage.
  - 3.8.3. Maintain concrete free of stains, discoloration, dirt, and other foreign material. Sweep concrete paving not more than 2 days prior to date scheduled for Substantial Completion inspections.

## **SECTION 07901 - JOINT SEALANTS**

### **PART 1. GENERAL**

#### **1.1. SUMMARY:**

1.1.1. This Section includes joint sealants for the following locations:

1.1.1.1. Exterior joints in vertical surfaces and nontraffic horizontal surfaces as indicated below:

1.1.1.2. Perimeter joints between unit masonry and louver frames.

1.1.1.3. Pipe and conduit penetrations.

1.1.1.4. Interior joints in vertical surfaces and horizontal nontraffic surfaces as indicated below:

1.1.1.4.1. Perimeter joints of exterior openings where indicated.

1.1.1.4.2. Pipe and conduit penetrations.

1.1.1.4.3. Other joints as indicated.

#### **1.2. SYSTEM PERFORMANCE REQUIREMENTS:**

1.2.1. Provide elastomeric joint sealants that have been produced and installed to establish and to maintain watertight and airtight continuous seals without causing staining or deterioration of joint substrates.

1.2.2. Provide joint sealants for interior applications that have been produced and installed to establish and maintain airtight continuous seals that are water resistant and cause no staining or deterioration of joint substrates.

#### **1.3. SUBMITTALS:**

1.3.1. General: Submit the following in accordance with Conditions of Contract.

1.3.2. Product data from manufacturers for each joint sealant product required.

#### **1.4. QUALITY ASSURANCE:**

1.4.1. Installer Qualifications: Engage an experienced Installer who has completed joint sealant applications similar in material, design, and extent to that indicated for Project that have resulted in construction with a record of successful in-service performance.

1.4.2. Single Source Responsibility for Joint Sealant Materials: Obtain joint sealant materials from a single manufacturer for each different product required.

1.5.        **DELIVERY, STORAGE, AND HANDLING:**

- 1.5.1.        Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials.
- 1.5.2.        Store and handle materials in compliance with manufacturer's recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.6.        **PROJECT CONDITIONS:**

- 1.6.1.        Environmental Conditions: Do not proceed with installation of joint sealants under the following conditions:
  - 1.6.1.1.        When ambient and substrate temperature conditions are outside the limits permitted by joint sealant manufacturer.
  - 1.6.1.2.        When joint substrates are wet.
- 1.6.2.        Joint Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than allowed by joint sealant manufacturer for application indicated.
- 1.6.3.        Joint Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.

**PART 2. PRODUCTS**

2.1.        **MATERIALS, GENERAL:**

- 2.1.1.        Compatibility: Provide joint sealants, joint fillers, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
- 2.1.2.        Colors: Provide color of exposed joint sealants to comply with the following:
  - 2.1.2.1.        Provide selections made by the Government from manufacturer's full range of standard colors for products of type indicated.

2.2.        **ELASTOMERIC JOINT SEALANTS:**

- 2.2.1.        Elastomeric Sealant Standard: Provide manufacturer's standard chemically curing elastomeric sealants that comply with ASTM C 920 and other requirements indicated on each Elastomeric Joint Sealant Data Sheet at end of this Section, including those requirements referencing ASTM C 920 classifications for Type, Grade, Class, and Uses.

- 2.2.2. Available Products: Subject to compliance with requirements, elastomeric sealants that may be incorporated in the Work include, but are not limited to, the products specified in each Elastomeric Sealant Data Sheet.
- 2.2.2.1. Location: ES1 - Provide at exterior vertical surfaces sealant joints.
- 2.3. **SOLVENT-RELEASE-CURING JOINT SEALANTS:**
- 2.3.1. Acrylic Sealant: Manufacturer's standard one-part, nonsag, solvent-release-curing acrylic terpolymer sealant complying with AAMA 808.3 of FS TT-S-00230 or both, with capability when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, to withstand the following percentage change in joint width existing at time of application and remain adhered to joint substrates indicated for Project without failing cohesively:
- 2.3.1.1. 12-1/2 percent movement in both extension and compression for a total of 25 percent.
- 2.3.2. Products: Subject to compliance with requirements, provide one of the following or equal:
- 2.3.2.1. Acrylic Sealant:
- "PTI 738", Protective Treatments, Inc.  
"PTI 767" Protective Treatment, Inc.  
"Mono," Tremco, Inc.
- 2.3.2.2. Location: Provide at interior vertical surfaces sealant joint locations not specified to receive another type joint sealant.
- 2.4. **JOINT SEALANT BACKING:**
- 2.4.1. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- 2.4.2. Plastic Foam Joint Fillers: Preformed, compressible, resilient, nonstaining, nonwaxing, nonextruding strips of flexible plastic foam of material indicated below and of size, shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
- 2.4.2.1. Proprietary, reticulated, closed-cell polymeric foam, nonoutgassing, with a density of 2.5 pcf (40 kg/cu. m) and tensile strength of 35 psi (240 kPa) per ASTM D 1623, and with water absorption less than 0.02 g/cc per ASTM C 1083.
- 2.5. **MISCELLANEOUS MATERIALS:**
- 2.5.1. Primer: Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated,

as determined from preconstruction joint sealant- substrate tests and field tests.

- 2.5.2. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming in any way joint substrates and adjacent nonporous surfaces, and formulated to promote optimum adhesion of sealants with joint substrates.

### **PART 3. EXECUTION**

#### **3.1. EXAMINATION:**

- 3.1.1. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint sealant performance. Do not proceed with installation of joint sealants until unsatisfactory conditions have been corrected.

#### **3.2. PREPARATION:**

- 3.2.1. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with recommendations of joint sealant manufacturer and the following requirements:
  - 3.2.1.1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
  - 3.2.1.2. Clean concrete, masonry, unglazed surfaces of ceramic tile, and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
  - 3.2.1.3. Clean metal, glass, glazed surfaces of ceramic tile, and other nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- 3.2.2. Joint Priming: Prime joint substrates where indicated or where recommended by joint sealant manufacturer based on preconstruction joint sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's recommendations. Confine primers to areas of joint sealant bond; do not allow spillage or migration onto adjoining surfaces.

#### **3.3. INSTALLATION OF JOINT SEALANTS:**

- 3.3.1. General: Comply with joint sealant manufacturer's printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.
- 3.3.2. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- 3.3.3. Installation of Sealant Backings: Install sealant backings to comply with the following requirements:
  - 3.3.3.1. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
    - 3.3.3.1.1. Do not leave gaps between ends of joint fillers.
    - 3.3.3.1.2. Do not stretch, twist, puncture, or tear joint fillers.
- 3.3.4. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at the same time sealant backings are installed.
- 3.3.5. Tooling of Nonsag Sealants: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
  - 3.3.5.1. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
- 3.4. **CLEANING:**
  - 3.4.1. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.
- 3.5. **PROTECTION:**
  - 3.5.1. Protect joint sealants during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration

occurs, cut out and remove damaged or deteriorated joint sealants immediately so that and installations with repaired areas are indistinguishable from original work.

**ELASTOMERIC JOINT SEALANT DATA SHEET**

Elastomeric Joint Designation: ES1

Base Polymer: Neutral-curing silicone.

Type: S (single component).

Grade: NS (nonsag).

Class: 25.

Use Related to Exposure: NT (nontraffic).

Uses Related to Joint Substrates: As applicable to joint substrates indicated, O.

Use O Joint Substrates: Glass, color anodized aluminum, unit masonry, and wood.

Available Products or equal:

"790" Dow Corning  
"Silpruf", GE  
"895", Pecora Corp.

## **SECTION 09255 - GYPSUM BOARD ASSEMBLIES**

### **PART 1. GENERAL**

#### **1.1. SUMMARY:**

1.1.1. This Section includes the following:

1.1.1.1. Nonload-bearing steel framing members for gypsum board assemblies.

1.1.1.2. Gypsum board assemblies attached to steel framing.

#### **1.2. DEFINITIONS:**

1.2.1. Gypsum Board Construction Terminology: Refer to ASTM C 11 and GA-505 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

#### **1.3. SUBMITTALS:**

1.3.1. No submittals required.

#### **1.4. QUALITY ASSURANCE:**

1.4.1. Single-Source Responsibility for Panel Products: Obtain each type of gypsum board and other panel products from a single manufacturer.

1.4.2. Single-Source Responsibility for Finishing Materials: Obtain finishing materials from either the same manufacturer that supplies gypsum board and other panel products or from a manufacturer acceptable to gypsum board manufacturer.

#### **1.5. DELIVERY, STORAGE, AND HANDLING:**

1.5.1. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

1.5.2. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Neatly stack gypsum panels flat to prevent sagging.

#### **1.6. PROJECT CONDITIONS:**

1.6.1. Environmental Conditions, General: Establish and maintain environmental conditions for applying and finishing gypsum board to comply with ASTM C 840 requirements or gypsum board manufacturer's recommendations, whichever are more stringent.

1.6.2. Room Temperatures: For nonadhesive attachment of gypsum board to framing, maintain not less than 40 deg F (4 deg C). For adhesive attachment and finishing of gypsum board, maintain not less than

50 deg F (10 deg C) for 48 hours before application and continuously after until dry. Do not exceed 95 deg F (35 deg C) when using temporary heat sources.

- 1.6.3. Ventilation: Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.

## **PART 2. PRODUCTS**

### **2.1. MANUFACTURERS:**

- 2.1.1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:

- 2.1.1.1. Gypsum Board and Related Products:

- 2.1.1.1.1. Domtar Gypsum.

- 2.1.1.1.2. National Gypsum Co.; Gold Bond Building Products Division.

- 2.1.1.1.3. United States Gypsum Co.

### **2.2. GYPSUM BOARD PRODUCTS:**

- 2.2.1. General: Provide gypsum board of types indicated in maximum lengths available that will minimize end-to-end butt joints in each area indicated to receive gypsum board application.

- 2.2.1.1. Widths: Provide gypsum board in widths of 48 inches (1219 mm).

- 2.2.2. Gypsum Wallboard: ASTM C 36 and as follows:

- 2.2.2.1. Type: Regular for vertical surfaces, unless otherwise indicated.

- 2.2.2.2. Edges: Tapered.

### **2.3. TRIM ACCESSORIES:**

- 2.3.1. Accessories for Interior Installation: Cornerbead, edge trim, and control joints complying with ASTM C 1047 and requirements indicated below:

- 2.3.1.1. Material: Formed metal or plastic, with metal complying with the following requirement:

- 2.3.1.1.1. Steel sheet zinc coated by hot-dip or electrolytic process, or steel sheet coated with aluminum or rolled zinc.

- 2.3.1.2. Shapes indicated below by reference to Fig. 1 designations in ASTM C 1047:

- 2.3.1.2.1. Cornerbead on outside corners, unless otherwise indicated.

- 2.3.1.2.2. LC-bead with both face and back flanges; face flange formed to receive joint compound. Use LC-beads for edge trim, unless

otherwise indicated.

2.4. **JOINT TREATMENT MATERIALS:**

- 2.4.1. General: Provide joint treatment materials complying with ASTM C 475 and the recommendations of both the manufacturers of sheet products and of joint treatment materials for each application indicated.
- 2.4.2. Joint Tape for Gypsum Board: Paper reinforcing tape, unless otherwise indicated.
- 2.4.3. Setting-Type Joint Compounds for Gypsum Board: Factory-packaged, job-mixed, chemical-hardening powder products formulated for uses indicated.
  - 2.4.3.1. Where setting-type joint compounds are indicated as a taping compound only or for taping and filling only, use formulation that is compatible with other joint compounds applied over it.
  - 2.4.3.2. For prefilling gypsum board joints, use formulation recommended by gypsum board manufacturer.
  - 2.4.3.3. For filling joints and treating fasteners of water-resistant gypsum backing board behind base for ceramic tile, use formulation recommended by gypsum board manufacturer.
  - 2.4.3.4. For topping compound, use sandable formulation.
- 2.4.4. Drying-Type Joint Compounds for Gypsum Board: Factory-packaged vinyl-based products complying with the following requirements for formulation and intended use.
  - 2.4.4.1. Ready-Mixed Formulation: Factory-mixed product.
    - 2.4.4.1.1. Taping compound formulated for embedding tape and for first coat over fasteners and face flanges of trim accessories.
    - 2.4.4.1.2. Topping compound formulated for fill (second) and finish (third) coats.
    - 2.4.4.1.3. All-purpose compound formulated for both taping and topping compounds.

2.5. **MISCELLANEOUS MATERIALS:**

- 2.5.1. General: Provide auxiliary materials for gypsum board construction that comply with referenced standards and recommendations of gypsum board manufacturer.
- 2.5.2. Gypsum Board nails: ASTM C 514.
- 2.5.3. Sound-Attenuation Blankets: Unfaced mineral-fiber blanket insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C 665 for Type I (blankets without membrane facing).

### **PART 3. EXECUTION**

#### **3.1. APPLYING AND FINISHING GYPSUM BOARD, GENERAL:**

- 3.1.1. Gypsum Board Application and Finishing Standards: Install and finish gypsum panels to comply with ASTM C 840 and GA- 216.
- 3.1.2. Install gypsum panels with face side out. Do not install imperfect, damaged, or damp panels. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
- 3.1.3. Locate both edge or end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Avoid joints other than control joints at corners of framed openings where possible.
- 3.1.4. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- 3.1.5. Attach gypsum panels to framing provided at openings and cutouts.
- 3.1.5.1. Fit gypsum panels around ducts, pipes, and conduits.
- 3.1.6. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's recommendations.

#### **3.2. GYPSUM BOARD APPLICATION METHODS:**

- 3.2.1. Single-Layer Application: Install gypsum wallboard panels as follows:
  - 3.2.1.1. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated, and provide panel lengths that will minimize end joints.

#### **3.3. INSTALLING TRIM ACCESSORIES:**

- 3.3.1. General: For trim accessories with back flanges, fasten to framing with the same fasteners used to fasten gypsum board. Otherwise, fasten trim accessories according to accessory manufacturer's directions for type, length, and spacing of fasteners.
- 3.3.2. Install cornerbead at external corners.
- 3.3.3. Install edge trim where edge of gypsum panels would otherwise be exposed. Provide edge trim type with face flange formed to receive joint compound, except where other types are indicated.
  - 3.3.3.1. Install LC-bead where gypsum panels are tightly abutted to other

construction and back flange can be attached to framing or supporting substrate.

3.4. **FINISHING GYPSUM BOARD ASSEMBLIES:**

- 3.4.1. General: Treat gypsum board joints, interior angles, flanges of cornerbead, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration.
- 3.4.2. Prefill open joints, rounded or beveled edges, and damaged areas using setting-type joint compound.
- 3.4.3. Apply joint tape over gypsum board joints, except those with trim accessories having flanges not requiring tape.
- 3.4.4. Apply joint tape over gypsum board joints and to flanges of trim accessories as recommended by trim accessory manufacturer.
- 3.4.5. Levels of Gypsum Board Finish: Provide the following levels of gypsum board finish per GA-214.
  - 3.4.5.1. Level 1 for Mechanical 207.
  - 3.4.5.2. Level 4 for gypsum board surfaces, unless otherwise indicated.
- 3.4.6. Use one of the following joint compound combinations as applicable to the finish levels specified:
  - 3.4.6.1. Embedding and First Coat: Setting-type joint compound. Fill (Second) Coat: Setting-type joint compound. Finish (Third) Coat: Ready-mixed, drying-type, all- purpose or topping compound.
  - 3.4.6.2. Embedding and First Coat: Ready-mixed, drying-type, all-purpose or taping compound. Fill (Second) Coat: Ready-mixed, drying-type, all-purpose or topping compound. Finish (Third) Coat: Ready-mixed, drying- type, all-purpose or topping compound.
- 3.4.7. For Level 4 gypsum board finish, embed tape in joint compound and apply first, fill (second), and finish (third) coats of joint compound over joints, angles, fastener heads, and accessories. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects and ready for decoration.
- 3.4.8. Where Level 1 gypsum board finish is indicated, embed tape in joint compound.

3.5. **CLEANING AND PROTECTION:**

- 3.5.1. Promptly remove any residual joint compound from adjacent surfaces.
- 3.5.2. Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure gypsum board assemblies are without damage or deterioration at the time of Substantial

Completion.

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## **SECTION 09511 - ACOUSTICAL PANEL CEILINGS**

### **PART 1. GENERAL**

#### **1.1. SUMMARY:**

- 1.1.1. This Section includes ceilings composed of acoustical panels and exposed suspension systems.

#### **1.2. SUBMITTALS:**

- 1.2.1. General: Submit each item in this Article according to the Conditions of the Contract.
- 1.2.2. Product data for each type of product specified.

#### **1.3. QUALITY ASSURANCE:**

- 1.3.1. Installer Qualifications: Engage an experienced Installer who has completed acoustical panel ceilings similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- 1.3.2. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:
  - 1.3.2.1. Fire-response tests are performed by a qualified testing and inspecting agency. Qualified testing and inspecting agencies include Underwriters Laboratories (UL), Warnock Hersey, or another agency that is acceptable to authorities having jurisdiction and that performs testing and follow-up services.
  - 1.3.2.2. Surface-burning characteristics of acoustical panels comply with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84.
- 1.3.3. Single-Source Responsibility for Ceiling Units: Obtain each type of acoustical ceiling panel from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.
- 1.3.4. Single-Source Responsibility for Suspension System: Obtain each type of suspension system from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.

#### **1.4. DELIVERY, STORAGE, AND HANDLING:**

- 1.4.1. Deliver acoustical panels and suspension system components to Project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.
- 1.4.2. Before installing acoustical panels, permit them to reach room

temperature and a stabilized moisture content.

- 1.4.3. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

- 1.5. **PROJECT CONDITIONS:**

- 1.5.1. Space Enclosure and Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet-work in spaces is completed and dry, work above ceilings is complete, and ambient temperature and humidity conditions are being maintained at the levels indicated for Project when occupied for its intended use.

- 1.6. **COORDINATION:**

- 1.6.1. Coordinate layout and installation of acoustical panels and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system components (if any), and partition assemblies (if any).

- 1.7. **EXTRA MATERIALS:**

- 1.7.1. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents.
    - 1.7.1.1. Acoustical Ceiling Units: Furnish quantity of full-size units equal to 48 square feet.

## **PART 2. PRODUCTS**

- 2.1. **MANUFACTURERS:**

- 2.1.1. Products: Subject to compliance with requirements, provide one of the following for each panel type indicated or equal:
    - 2.1.1.1. Non-Fire-Resistance-Rated, Water-Felted, Mineral-Base Panels:
      - 2.1.1.1.1. Minaboard Cortega; Armstrong World Industries, Inc.
      - 2.1.1.1.2. Hytone Baroque; The Celotex Corporation.
      - 2.1.1.1.3. Auratone Omni Fissured; USG Interiors, Inc.

- 2.2. **ACOUSTICAL PANELS, GENERAL:**

- 2.2.1. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.
    - 2.2.1.1. Mounting Method for Measuring Noise Reduction Coefficient (NRC): Type E-400 [plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from the test surface] per ASTM E 795.

- 2.2.1.2. Test Method for Ceiling Attenuation Class (CAC): Where acoustical panel ceilings are specified to have a CAC, provide units identical to those tested per ASTM E 1414 by a qualified testing agency.
- 2.2.2. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
- 2.3. **CEILINGS OF WATER-FELTED, MINERAL-BASE ACOUSTICAL PANELS:**
- 2.3.1. Panel Characteristics: Type III, Form 2 acoustical panels per ASTM E 1264, with painted finish, complying with pattern and other requirements indicated below:
  - 2.3.1.1. Pattern: Panels matching pattern indicated by reference to manufacturer's standard product designations in "Manufacturers" Article.
  - 2.3.1.2. Pattern: Panels fitting ASTM E 1264 pattern designations (pattern description) indicated below:
    - 2.3.1.2.1. Designation CD (perforated with small holes and fissured).
  - 2.3.1.3. Color: White.
  - 2.3.1.4. Noise Reduction Coefficient: NRC 0.65.
  - 2.3.1.5. Ceiling Sound Transmission Class: CSTC 35.
  - 2.3.1.6. Edge Detail: Tegular (reveal sized to fit flange of exposed suspension system members).
  - 2.3.1.7. Thickness: 3/4 inch (19 mm).
  - 2.3.1.8. Size: 24 by 24 inches (610 by 610 mm).
- 2.3.2. Suspension System Type: As described below and specified in Part 2 "Non-Fire-Resistance-Rated, Direct-Hung Suspension Systems" Article:
  - 2.3.2.1. Wide-face, single-web, steel suspension system.
- 2.4. **METAL SUSPENSION SYSTEMS, GENERAL:**
- 2.4.1. Metal Suspension System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable ASTM C 635 requirements.
- 2.4.2. Finishes and Colors: Provide manufacturer's standard factory-applied finish for type of system indicated.
- 2.4.3. Attachment Devices: Size for 5 times the design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.

- 2.4.4. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
  - 2.4.4.1. Zinc-Coated Carbon Steel Wire: ASTM A 641 (ASTM A 641M), Class 1 zinc coating, soft temper.
  - 2.4.4.2. Size: Select wire diameter so that its stress at 3 times the hanger design load (ASTM C 635, Table 1, Direct Hung) will be less than the yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) diameter wire.
- 2.4.5. Sheet-Metal Edge Moldings and Trim: Type and profile indicated, or if not indicated, manufacturer's standard moldings for edges and penetrations that fit acoustical panel edge details and suspension systems indicated; formed from sheet metal of same material and finish as that used for exposed flanges of suspension system runners.
- 2.5. **NON-FIRE-RESISTANCE-RATED, DIRECT-HUNG SUSPENSION SYSTEMS:**
  - 2.5.1. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from prepainted or electrolytic zinc-coated, cold-rolled steel sheet, with prefinished 15/16-inch- (24-mm-) wide metal caps on flanges; other characteristics as follows:
    - 2.5.1.1. Structural Classification: Intermediate-duty system.
    - 2.5.1.2. End Condition of Cross Runners: Override (stepped) or butt-edge type, as standard with manufacturer.
    - 2.5.1.3. Cap Material and Finish: Steel sheet painted white.
  - 2.5.2. Products: Subject to compliance with requirements, provide one of the following:
    - 2.5.2.1. Wide-Face, Capped, Double-Web, Steel Suspension Systems equal to:
      - 2.5.2.1.1. Prelude 15/16" Exposed Tee System (w/7300 m.r.); Armstrong World Industries, Inc.
      - 2.5.2.1.2. 1200 System/211-219 Main Tee; Chicago Metallic Corporation.
      - 2.5.2.1.3. DX 24 System; USG Interiors, Inc.
- 2.6. **ACOUSTICAL SEALANT:**
  - 2.6.1. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 and the following requirements:
    - 2.6.1.1. Product is effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies per ASTM E 90.
  - 2.6.2. Acoustical Sealant for Concealed Joints: Manufacturer's standard

nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic rubber sealant recommended for sealing interior concealed joints to reduce transmission of airborne sound.

2.6.3. Products: Subject to compliance with requirements, provide one of the following or equal:

2.6.3.1. Acoustical Sealant for Exposed and Concealed Joints:

2.6.3.1.1. AC-20 FTR Acoustical and Insulation Sealant; Pecora Corp.

2.6.3.1.2. SHEETROCK Acoustical Sealant; United States Gypsum Company.

2.6.3.2. Acoustical Sealant for Concealed Joints:

2.6.3.2.1. BA-98; Pecora Corp.

2.6.3.2.2. Tremco Acoustical Sealant; Tremco, Inc.

### **PART 3. EXECUTION**

#### **3.1. EXAMINATION:**

3.1.1. Examine substrates and structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage. Do not proceed with installation until unsatisfactory conditions have been corrected.

#### **3.2. PREPARATION:**

3.2.1. Measure each ceiling area and establish the layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and conform to the layout shown on reflected ceiling plans.

#### **3.3. INSTALLATION:**

3.3.1. General: Install acoustical panel ceilings to comply with publications referenced below per manufacturer's instructions and CISCA "Ceiling Systems Handbook."

3.3.1.1. Standard for Ceiling Suspension System Installations: Comply with ASTM C 636.

3.3.2. Suspend ceiling hangers from building's structural members and as follows:

3.3.2.1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of the supporting structure or of the ceiling suspension system.

3.3.2.2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

- 3.3.2.3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- 3.3.2.4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of 3 tight turns. Connect hangers either directly to structures or to inserts, eye screws, or other devices that are secure, that are appropriate for substrate, and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
- 3.3.2.5. Do not attach hangers to steel roof deck. Attach hangers to structural members.
- 3.3.2.6. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers, unless otherwise shown; and provide hangers not more than 8 inches (200 mm) from ends of each member.
- 3.3.2.7. Provide hangers at all four corners of lighting fixtures.
- 3.3.3. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
  - 3.3.3.1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
  - 3.3.3.2. Screw attach moldings to substrate at intervals not over 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.18 mm in 3.66 m). Miter corners accurately and connect securely.
  - 3.3.3.3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- 3.3.4. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- 3.3.5. Install acoustical panels with undamaged edges and fitted accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide neat, precise fit.
  - 3.3.5.1. Arrange directionally patterned acoustical panels as follows:
    - 3.3.5.1.1. Install panels with pattern running in one direction parallel to short axis of space.

- 3.3.5.2. For reveal-edge panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
- 3.3.5.2.1. Where panel edge is cut to fit the grid touch up exposed edge with white color to match panel face.
- 3.4. **CLEANING:**
- 3.4.1. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

## **SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS**

### **PART 1. GENERAL**

#### **1.1. SUMMARY:**

- 1.1.1. This Section includes the following basic mechanical materials and methods to complement other Division 15 Sections.
  - 1.1.1.1. Equipment nameplate data requirements.
  - 1.1.1.2. Installation requirements common to equipment specification Sections.
  - 1.1.1.3. Mechanical demolition.
  - 1.1.1.4. Cutting and patching.
  - 1.1.1.5. Touchup painting and finishing.

#### **1.2. DEFINITIONS:**

- 1.2.1. Pipe, pipe fittings, and piping include tube, tube fittings, and tubing.
- 1.2.2. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- 1.2.3. Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- 1.2.4. Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- 1.2.5. Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- 1.2.6. Concealed Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

#### **1.3. QUALITY ASSURANCE:**

- 1.3.1. ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.
- 1.3.2. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such

proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

1.4. **SEQUENCING AND SCHEDULING:**

- 1.4.1. Coordinate mechanical equipment installation with other building components.
- 1.4.2. Arrange for chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- 1.4.3. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work.
- 1.4.4. Coordinate connection of electrical services.
- 1.4.5. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces.

**PART 2. PRODUCTS**

2.1. **IDENTIFYING DEVICES AND LABELS:**

- 2.1.1. Plastic Equipment Markers: Laminated-plastic, color-coded equipment markers. Conform to following color code:
  - 2.1.1.1. Green: Cooling equipment and components.
  - 2.1.1.2. Yellow: Heating equipment and components.
  - 2.1.1.3. Yellow/Green: Combination cooling and heating equipment and components.
  - 2.1.1.4. Blue: Equipment and components that do not meet any of the above criteria.
  - 2.1.1.5. For hazardous equipment, use colors and designs recommended by ASME A13.1.
  - 2.1.1.6. Nomenclature: Include following, matching terminology on schedules as closely as possible:
    - 2.1.1.6.1. Name and plan number.
    - 2.1.1.6.2. Equipment service.
    - 2.1.1.6.3. Design capacity.

- 2.1.1.6.4. Other design parameters such as pressure drop, entering and leaving conditions, and rpm.
- 2.1.1.7. Size: Approximately 2-1/2 by 4 inches (65 by 100 mm) for control devices, dampers, and valves; and 4-1/2 by 6 inches (115 by 150 mm) for equipment.
- 2.1.2. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, lettering, and wording indicated for proper identification and operation/maintenance of mechanical systems and equipment.
- 2.1.2.1. Multiple Systems: Where multiple systems of same generic name are indicated, provide identification that indicates individual system number as well as service such as "Boiler No. 3," "Air Supply No. 1H," or "Standpipe F12."

### **PART 3. EXECUTION**

- 3.0.1. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Contracting Officer's representative.
- 3.0.2. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.
- 3.0.3. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
- 3.0.4. Equipment: Install engraved plastic laminate sign or equipment marker on or near each major item of mechanical equipment.
- 3.0.4.1. Lettering Size: Minimum 1/4-inch (6-mm) -high lettering for name of unit where viewing distance is less than 2 feet (0.6 m), 1/2-inch (13-mm) -high for distances up to 6 feet (1.8 m), and proportionately larger lettering for greater distances. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.
- 3.0.4.2. Text of Signs: Provide text to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to name of identified unit.
- 3.1. **PAINTING AND FINISHING:**
- 3.1.1. Damage and Touch Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory

finish.

- 3.1.2. All exposed mechanical equipment and appurtances to be painted a color as specified by the Contracting Officer's Representative.

- 3.2. **DEMOLITION:**

- 3.2.1. Disconnect, demolish, and remove work specified under Division 15 and as indicated.
- 3.2.2. Where pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
- 3.2.3. Removal: Remove indicated equipment from the Project site.

- 3.3. **CUTTING AND PATCHING:**

- 3.3.1. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.
- 3.3.2. Repair cut surfaces to match adjacent surfaces.

END OF SECTION 15050

## **SECTION 15145 - HANGERS AND SUPPORTS**

### **PART 1. GENERAL**

#### **1.1. SUMMARY:**

- 1.1.1. This Section includes hangers and supports for mechanical systems piping and equipment.

#### **1.2. DEFINITIONS:**

- 1.2.1. Terminology used in this Section is defined in MSS SP-90.

#### **1.3. QUALITY ASSURANCE:**

- 1.3.1. NFPA Compliance: Comply with NFPA 13 for hangers and supports used as components of fire protection systems.
- 1.3.2. Listing and Labeling: Provide hangers and supports that are listed and labeled as defined in NFPA 70, Article 100.
  - 1.3.2.1. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- 1.3.3. Licensed Operators: Use operators that are licensed by powder-operated tool manufacturers to operate their tools and fasteners.

### **PART 2. PRODUCTS**

#### **2.1. MANUFACTURED UNITS:**

- 2.1.1. Hangers, Supports, and Components: Factory-fabricated according to MSS SP-58.
  - 2.1.1.1. Components include galvanized coatings where installed for piping and equipment that will not have a field-applied finish.
  - 2.1.1.2. Pipe attachments include nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.
- 2.1.2. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.

#### **2.2. MISCELLANEOUS MATERIALS:**

- 2.2.1. Structural Steel: ASTM A 36 (ASTM A 36M), steel plates, shapes, and bars, black and galvanized.

- 2.2.2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex-head, track bolts and nuts.
- 2.2.3. Washers: ASTM F 844, steel, plain, flat washers.
- 2.2.3.1. Characteristics include post-hardening, volume- adjusting, dry, hydraulic-cement-type grout that is nonstaining, noncorrosive, nongaseous and is recommended for both interior and exterior applications.
- 2.2.3.2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- 2.2.3.3. Water: Potable.
- 2.2.3.4. Packaging: Premixed and factory-packaged.

### **PART 3. EXECUTION**

#### **3.1. HANGER AND SUPPORT APPLICATIONS:**

- 3.1.1. Specific hanger requirements are specified in the Section specifying the equipment and systems.
- 3.1.2. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping specification Sections.

#### **3.2. HANGER AND SUPPORT INSTALLATION:**

- 3.2.1. General: Comply with MSS SP-69 and SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- 3.2.2. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible.
- 3.2.3. Install supports with maximum spacings complying with MSS SP-69.
- 3.2.4. Where pipes of various sizes are supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
- 3.2.5. Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Install reinforcing bars through openings at top of inserts.
- 3.2.6. Install powder-actuated drive-pin fasteners in concrete after

concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches (100 mm) thick.

- 3.2.7. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- 3.2.8. Heavy-Duty Steel Trapezes: Field-fabricate from ASTM A 36 steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- 3.2.9. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- 3.2.10. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- 3.2.11. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded.
- 3.2.12. Insulated Piping: Comply with the following installation requirements.
  - 3.2.12.1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.
  - 3.2.12.2. Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
  - 3.2.12.3. Shields: Install MSS Type 40, protective shields on cold piping with vapor barrier. Shields span an arc of 180 degrees (3.1 rad) and have dimensions in inches (mm) not less than the following:

LENGTH	THICKNESS
NPS (Inches)	(Inches) (Inches)
1/4 to 3-1/2	12 0.048

- 3.2.12.4. Insert Material: Length at least as long as the protective shield.
- 3.3. **ADJUSTING:**
  - 3.3.1. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.4.        **PAINTING:**

- 3.4.1.       Touching Up: Clean field welds and abraded areas of shop paint and paint exposed areas immediately after erection of hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
- 3.4.1.1.     Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
- 3.4.2.       Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal is specified in Division 9 Section "Painting."
- 3.4.3.       Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

## **SECTION 15250 - MECHANICAL INSULATION**

### **PART 1. GENERAL**

#### **1.1. SUMMARY:**

- 1.1.1. This Section includes duct insulation.

#### **1.2. DEFINITIONS:**

- 1.2.1. Dual-Temperature Surfaces: Normal operating temperatures that vary from hot to cold.
- 1.2.2. Thermal resistivity is designated by an r-value that represents the reciprocal of thermal conductivity (k-value). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1 inch (25.4 mm) thick. Thermal resistivity (r-value) is expressed by the temperature difference in degrees Fahrenheit (Kelvins) between the two exposed faces required to cause 1 BTU per hour (1 Watt) to flow through 1 square foot (1 square meter) at mean temperatures indicated.
- 1.2.3. Thermal Conductivity (k-value): Measure of heat flow through a material at a given temperature difference; conductivity is expressed in units of Btu x inch/h x sq. ft. x deg F (W x m/sq. m x K).
- 1.2.4. Density: Is expressed in pcf (kg/cu. m).

#### **1.3. SUBMITTALS:**

- 1.3.1. Product data for each type of mechanical insulation identifying k-value, thickness, and accessories.
- 1.3.2. Material certificates, signed by the manufacturer, certifying that materials comply with specified requirements where laboratory test reports cannot be obtained.

#### **1.4. QUALITY ASSURANCE:**

- 1.4.1. Fire Performance Characteristics: Conform to the following characteristics for insulation including facings, cements, and adhesives, when tested according to ASTM E 84, by UL or other testing or inspecting organization acceptable to the authority having jurisdiction. Label insulation with appropriate markings of testing laboratory.
  - 1.4.1.1. Interior Insulation: Flame spread rating of 25 or less and a smoke developed rating of 50 or less.
  - 1.4.1.2. Exterior Insulation: Flame spread rating of 75 or less and a smoke developed rating of 150 or less.

1.5.           **SEQUENCING AND SCHEDULING:**

1.5.1.       Schedule insulation application after testing of duct systems.

**PART 2. PRODUCTS**

2.1.           **MANUFACTURERS:**

2.1.1.       Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

2.1.1.1.     Glass Fiber:

2.1.1.1.1.   CertainTeed Corporation.

2.1.1.1.2.   Knauf Fiberglass GmbH.

2.1.1.1.3.   Manville.

2.1.1.1.4.   Owens-Corning Fiberglas Corporation.

2.1.1.1.5.   USG Interiors, Inc. - Thermafiber Division.

2.2.           **GLASS FIBER:**

2.2.1.       Material: Inorganic glass fibers, bonded with a thermosetting resin.

2.2.2.       Jacket: All-purpose, factory-applied, laminated glass- fiber-reinforced, flame-retardant kraft paper and aluminum foil having self-sealing lap.

2.2.3.       Board: ASTM C 612, Class 2, semi-rigid jacketed board.

2.2.3.1.     Thermal Conductivity: 0.26 average maximum, at 75 deg F mean temperature.

2.2.3.2.     Density: 12 Pcf average maximum.

2.2.4.       Blanket: ASTM C 553, Type II, Class F-1, jacketed flexible blankets.

2.2.5.       Blanket: ASTM C 553, Type II, Class F-1, jacketed flexible blankets.

2.2.5.1.     Thermal Conductivity: 0.32 Btu x inch/h x sq. ft. x deg F (0.046 W x m/sq. m x K) average maximum, at 75 deg F (24 deg C) mean temperature.

2.2.6.       Adhesive: Produced under the UL Classification and Follow- up service.

- 2.2.6.1. Type: Non-flammable, solvent-based.
- 2.2.6.2. Service Temperature Range: Minus 20 to 180 deg F (Minus 29 to 82 deg C).
- 2.2.7. Vapor Barrier Coating: Waterproof coating recommended by insulation manufacturer for outside service.
- 2.3. **INSULATING CEMENTS:**
  - 2.3.1. Mineral Fiber: ASTM C 195.
    - 2.3.1.1. Thermal Conductivity: 1.0 Btu x inch/h x sq. ft. x deg F (0.14 W x m/sq. m x K) average maximum at 500 deg F (260 deg C) mean temperature.
    - 2.3.1.2. Compressive Strength: 10 psi (70 kPa) at 5 percent deformation.
  - 2.3.2. Mineral Fiber, Hydraulic-Setting Insulating and Finishing Cement: ASTM C 449.
    - 2.3.2.1. Thermal Conductivity: 1.2 Btu x inch/h x sq. ft. x deg F (0.173 W x m/sq. m x K) average maximum at 400 deg F (204 deg C) mean temperature.
    - 2.3.2.2. Compressive Strength: 100 psi (690 kPa) at 5 percent deformation.
- 2.4. **ADHESIVES:**
  - 2.4.1. Lagging Adhesive: MIL-A-3316C, non-flammable adhesive in the following Classes and Grades:
    - 2.4.1.1. Class 2, Grade A for bonding glass fiber insulation to metal surfaces.
- 2.5. **JACKETS:**
  - 2.5.1. General: ASTM C 921, Type 1, except as otherwise indicated.
  - 2.5.2. Foil and Paper Jacket: Laminated glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.
    - 2.5.2.1. Water Vapor Permeance: 0.02 perm (1.2 ng/Pa/s/sq. m) maximum, when tested according to ASTM E 96.
    - 2.5.2.2. Puncture Resistance: 50 beach units minimum, when tested according to ASTM D 781.
- 2.6. **ACCESSORIES AND ATTACHMENTS:**
  - 2.6.1. Glass Cloth and Tape: Woven glass fiber fabrics, plain weave, presized a minimum of 8 ounces per sq. yd. (272 gm per sq. m).

- 2.6.1.1. Tape Width: 4 inches (102 mm).
- 2.6.1.2. Cloth Standard: MIL-C-20079H, Type I.
- 2.6.1.3. Tape Standard: MIL-C-20079H, Type II.
- 2.6.2. Bands: 3/4 inch (19 mm) wide, in one of the following materials compatible with jacket:
  - 2.6.2.1. Stainless Steel: Type 304, 0.020 inch (0.5 mm) thick.
  - 2.6.2.2. Galvanized Steel: 0.005 inch (0.13 mm) thick.
  - 2.6.2.3. Aluminum: 0.007 inch (0.18 mm) thick.
  - 2.6.2.4. Brass: 0.01 inch (0.25 mm) thick.
  - 2.6.2.5. Nickel-Copper Alloy: 0.005 inch (0.13 mm) thick.
- 2.6.3. Anchor Pins: Capable of supporting 20 pounds (9 kg) each. Provide anchor pins and speed washers of sizes and diameters as recommended by the manufacturer for insulation type and thickness.
- 2.7. **SEALING COMPOUNDS:**
  - 2.7.1. Vapor Barrier Compound: Water-based, fire-resistive composition.
    - 2.7.1.1. Water Vapor Permeance: 0.08 perm (4.6 ng/Pa/s/sq. m) maximum.
    - 2.7.1.2. Temperature Range: Minus 20 to 180 deg F (Minus 29 to 82 deg C).
  - 2.7.2. Weatherproof Sealant: Flexible-elastomer-based, vapor- barrier sealant designed to seal metal joints.
    - 2.7.2.1. Water Vapor Permeance: 0.02 perm (1.2 ng/Pa/s/sq. m) maximum.
    - 2.7.2.2. Temperature Range: Minus 50 to 250 deg F (Minus 46 to 121 deg C).
    - 2.7.2.3. Color: Aluminum.

### **PART 3. EXECUTION**

- 3.1. **PREPARATION:**
  - 3.1.1. Surface Preparation: Clean, dry, and remove foreign materials such as rust, scale, and dirt.
  - 3.1.2. Mix insulating cements with clean potable water. Mix insulating cements contacting stainless-steel surfaces with demineralized water.
    - 3.1.2.1. Follow cement manufacturer's printed instructions for mixing and portions.

3.2.        **INSTALLATION, GENERAL:**

- 3.2.1.       Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each mechanical system.
- 3.2.2.       Select accessories compatible with materials suitable for the service. Select accessories that do not corrode, soften, or otherwise attack the insulation or jacket in either the wet or dry state.
- 3.2.3.       Install vapor barriers on insulated ducts, and equipment having surface operating temperatures below 60 deg F (16 deg C).
- 3.2.4.       Apply insulation material, accessories, and finishes according to the manufacturer's printed instructions.
- 3.2.5.       Install insulation with smooth, straight, and even surfaces.
- 3.2.6.       Seal joints and seams to maintain vapor barrier on insulation requiring a vapor barrier.
- 3.2.7.       Seal penetrations for hangers, supports, anchors, and other projections in insulation requiring a vapor barrier.
- 3.2.8.       Seal Ends: Except for flexible elastomeric insulation, taper ends at 45 degree angle and seal with lagging adhesive. Cut ends of flexible elastomeric cellular insulation square and seal with adhesive.
- 3.2.9.       Apply adhesives and coatings at manufacturer's recommended coverage-per-gallon rate.
- 3.2.10.      Keep insulation materials dry during application and finishing.

3.3.        **DUCT INSULATION:**

- 3.3.1.       Install block and board insulation as follows:
  - 3.3.1.1.     Adhesive and Bank Attachment: Secure block and board insulation tight and smooth with a least 50 percent coverage of adhesive. Install bands spaced 12 inches apart. Protect insulation under bands and at exterior corners with metal corner angles. Fill joints, seams, and chipped edges with vapor barrier compound.
  - 3.3.1.2.     Speed Washers Attachment: Secure insulation tight and smooth with speed washers and welded pins. Space anchor pins 18 inches apart each way and 3 inches from insulation joints. Apply vapor barrier coating compound to insulation in contact, open joints, breaks, punctures, and voids in insulation.
- 3.3.2.       Blanket Insulation: Install tight and smooth. Secure to ducts having long sides or diameters as follows:

- 3.3.2.1. Smaller Than 24 Inches (610 mm): Bonding adhesive applied in 6 inches (150 mm) wide transverse strips on 12 inches (300 mm) centers.
- 3.3.2.2. 24 Inches (610 mm) and Larger: Anchor pins spaced 12 inches (300 mm) apart each way. Apply bonding adhesive to prevent sagging of the insulation.
- 3.3.2.3. Overlap joints 3 inches (75 mm).
- 3.3.2.4. Seal joints, breaks, and punctures with vapor barrier compound.
- 3.4. **JACKETS:**
  - 3.4.1. Foil and Paper Jackets (FP): Install jackets drawn tight. Install lap or butt strips at joints with material same as jacket. Secure with adhesive. Install jackets with 1-1/2 inches (40 mm) laps at longitudinal joints and 3 inch (75 mm) wide butt strips at end joints.
    - 3.4.1.1. Seal openings, punctures, and breaks in vapor barrier jackets and exposed insulation with vapor barrier compound.
  - 3.4.2. Exterior Exposed Insulation: Install continuous aluminum jackets and seal all joints and seams with waterproof sealant.
  - 3.4.3. Install metal jacket with 2 inches (50 mm) overlap at longitudinal and butt joints. Overlap longitudinal joints to shed water. Seal butt joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel draw bands 12 inches (300 mm) on center and at butt joints.
- 3.5. **APPLICATIONS:**
  - 3.5.1. General: Materials and thicknesses are specified in schedules at the end of this Section.
  - 3.5.2. Duct Systems: Unless otherwise indicated, insulate the following duct systems:
    - 3.5.2.1. Interior concealed supply, return and outside air ductwork.
    - 3.5.2.2. Interior exposed supply, return and outside air ductwork.
    - 3.5.2.3. Exterior exposed supply and return ductwork.
    - 3.5.2.4. Interior exposed and concealed supply fans, air handling unit casings and outside air plenums.
- 3.6. **DUCT SYSTEMS INSULATION SCHEDULE**

INTERIOR CONCEALED HVAC SUPPLY AND RETURN DUCTS AND PLENUMS

<u>MATERIAL</u>	<u>FORM</u>	<u>INCHES</u>	<u>JACKET</u>
GLASS FIBER BLANKET	1-1/2	NONE	

INTERIOR EXPOSED HVAC SUPPLY AND RETURN DUCTS AND PLENUMS

<u>MATERIAL</u>	<u>FORM</u>	<u>INCHES</u>	<u>JACKET</u>
GLASS FIBER BOARD RECT.	1-1/2	NONE	
GLASS FIBER PIPE ROUND	1-1/2	NONE	

EXTERIOR CONCEALED HVAC SUPPLY AND RETURN DUCTS AND PLENUMS

<u>MATERIAL</u>	<u>FORM</u>	<u>INCHES</u>	<u>JACKET</u>
GLASS FIBER BOARD RECT.	2	NONE	
GLASS FIBER PIPE ROUND	2	NONE	

SECTION 15510 - PIPE AND PIPE FITTINGS (HYDRONIC)

PART 1 - GENERAL

1.1 SCOPE:

1.1.1 This section includes all pipe, pipe fittings, hangers, and supports, specialties, etc. as may be required to provide a complete water piping system.

1.2 TESTING:

1.2.1 Of all piping shall be made in the presence of the contracting officer's representative. No piping shall be covered or put into operation before such testing has been approved.

1.3 THE ACTUAL ARRANGEMENT OF PIPING:

1.3.1 Shall follow the general locations shown on the Drawings, such that clearance, line drainage, etc. shall be maintained.

1.4 **PIPING SHALL BE OF U.S. ORIGIN AND MANUFACTURED AND SHALL BE SO MARKED. NO FOREIGN PIPE OR FITTINGS SHALL BE SUBSTITUTED.**

PART 2: PRODUCTS

2.1 PIPING:

2.1.1 3/8" and smaller shall be standard weight, Schedule 80, black steel pipe conforming to ASTM specification A-120.

2.2 PIPING:

2.2.1 1/2" and larger shall be standard weight, Schedule 40, black steel pipe conforming to ASTM Specification A-120.

2.3 STANDARD WEIGHT WELDING FITTINGS:

Shall be used and shall conform to ASTM A-234.

2.4 SCREWED FITTINGS

2.4.1 Shall be malleable iron, 150 lb. S.W. P., with banded pattern conforming to ANSI B16.3.

2.5 HANGERS AND SUPPORTS:

2.5.1 See Specification Section 15145.

2.6            HYDRONIC SPECIALTIES

- 2.6.1            MANUAL AIR VENT: Bronze body and nonferrous internal parts; 150 psig working pressure, 225 deg f operating temperature; manually operated with screwdriver or thumbscrew; with 1/8 inch NPS discharge connection and 1/2 NPS inlet connection.
- 2.6.3            COMPRESSION TANKS: Welded carbon steel for 125 psig working pressure, 375 deg f maximum operating temperature. Provide taps in bottom of tank for tank fittings; taps in end of tank for gage glass. Factory test tank with taps fabricated and labeled according to ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. Furnish with the following fittings and accessories.
- 2.6.3.1            AIR CONTROL TANK FITTING: cast iron body, copper plated tube, brass vent tube plug, and stainless steel ball check, 100 gal unit only; sized for compression tank diameter. Design tank fittings for 125 psig working pressure and 250 deg F maximum operating temperature.
- 2.6.3.2            TANK DRAIN FITTING: Brass body, nonferrous internal parts; 125 psig working pressure and 240 deg f maximum operating temperature; designed to admit air to compression tank, drain water and close off system.
- 2.6.3.3            GAGE GLASS: Full height with dual manual shutoff valves, 3/4" diameter gage glass and slotted metal glass guard.
- 2.6.4            AIR SEPARATORS: Welded steel ASME constructed and labeled for 125 psig minimum working pressure and 375 deg f maximum operating temperature; perforated stainless steel air collector tube designed to direct released air into compression tank; tangential inlet and outlet connections for 2" NPS and smaller flanged connection for 1 1/2" NPS and larger threaded blow-down connection. Provide units in sizes for full system flow capacity.

PART 3:    EXECUTION

- 3.1            PIPE 2" AND SMALLER:
- 3.1.1            Shall have screwed joints.
- 3.2            PIPE 2-1/2" AND LARGER:
- 3.2.1            Shall be welded.
- 3.3            WELDING TEES

- 3.3.1 Or weldolets shall be used.
- 3.4 NO "STUB-IN":
- 3.4.1 Shall be permitted.
- 3.5 ALL INSULATED PIPING:
- 3.5.1 Shall be protected by insert saddles at horizontal support points or by insulation protectors if the insulation has a vapor barrier. Insert saddles where used shall be welded to the pipe.
- 3.5.2 In no case shall the Contractor be allowed to cut or reduce the specified covering to allow the application of a smaller hanger than required.
- 3.6 SLEEVES:
- 3.6.1 Shall be provided wherever pipes pass through walls, floors and ceilings. Sleeves shall be Schedule 40, black steel, 1/2" in diameter larger than the pipe or insulation on the pipe. Sleeves through walls and ceilings shall be flush. Sleeves through floors shall extend one inch above finished floor. Sleeves in exterior walls shall be caulked and made watertight.
- 3.7 DISSIMILIAR MATERIALS:
- 3.7.1 Whenever piping of dissimilar materials are to be joined together, they are to be isolated from each other at their junction by an insulating union which shall prevent electrolysis.
- 3.8 TESTING:
- 3.8.1 All hydronic piping systems shall be hydrostatically tested at 150 psi for a period of not less than four (4) hours without loss of pressure. Any leaks that occur shall be repaired and another test started.

3.9

INSULATION:

3.9.1

All interior hydronic piping shall have 1 1/2" fiberglass insulation with kraft paper jacket.

## **SECTION 15520 - STEAM AND CONDENSATE PIPING**

### **PART 1. GENERAL**

#### **1.1. SUMMARY:**

- 1.1.1. This Section includes steam and condensate piping and specialties for building HVAC systems, including pipes, fittings, special-duty valves, and specialties.

#### **1.2. SYSTEM DESCRIPTION:**

- 1.2.1. Steam and condensate piping systems for this Project are 2- pipe, mechanical flow, up-feed systems.

#### **1.3. QUALITY ASSURANCE:**

- 1.3.1. ASME Compliance: Comply with the following provisions:
  - 1.3.1.1. ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
  - 1.3.1.2. Welding Standards: Qualify welding processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."

#### **1.4. COORDINATION:**

- 1.4.1. Coordinate layout and installation of piping with steam and condensate equipment and with other installations.
- 1.4.2. Coordinate pipe sleeve installation for foundation wall penetrations.
- 1.4.3. Coordinate pipe fitting pressure classes with products specified in related Sections.

### **PART 2. PRODUCTS**

#### **2.1. MANUFACTURERS:**

- 2.1.1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
  - 2.1.2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 2.1.2.1. Steam Traps:
      - 2.1.2.1.1. Armstrong International, Inc.
      - 2.1.2.1.2. Barnes & Jones, Inc.

- 2.1.2.1.3. Dunham-Bush, Inc.
- 2.1.2.1.4. ITT Hoffman; ITT Fluid Handling Div.
- 2.1.2.1.5. Spirax Sarco, Inc.
- 2.1.2.1.6. Sterling, Inc.
- 2.1.2.1.7. Trane Co. (The).
- 2.1.2.2. Air Vents and Vacuum Breakers:
  - 2.1.2.2.1. Armstrong International, Inc.
  - 2.1.2.2.2. Barnes & Jones, Inc.
  - 2.1.2.2.3. ITT Hoffman; ITT Fluid Handling Div.
  - 2.1.2.2.4. Johnson Corp. (The).
  - 2.1.2.2.5. Spirax Sarco, Inc.
  - 2.1.2.2.6. Trane Co. (The).
- 2.2. **PIPE AND TUBING MATERIALS:**
  - 2.2.1. General: Refer to Part 3 pipe application articles for identifying where the following materials are used.
  - 2.2.2. Steel Pipe, 2-Inch NPS (DN50) and Smaller: ASTM A 53, Type S (seamless), Grade A, Schedules 40 and 80, plain ends.
    - 2.2.2.1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedules 40 and 80, carbon steel, seamless for 2-inch NPS (DN50) and smaller.
- 2.3. **FITTINGS:**
  - 2.3.1. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300.
  - 2.3.2. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300.
  - 2.3.3. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.
  - 2.3.4. Cast-Iron Threaded Flanges: ASME B16.1, Classes 125 and 250; raised ground face, bolt holes spot faced.
  - 2.3.5. Wrought-Steel Fittings: ASTM A 234 (ASTM A 234M), Schedules 40 and 80.
  - 2.3.6. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

- 2.3.6.1. Material Group: 1.1.
- 2.3.6.2. End Connections: Butt welding.
- 2.3.6.3. Facings: Raised face.
- 2.3.7. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150- psig (1035-kPa) minimum working pressure, 250 deg F (121 deg C) maximum operating temperature. Connectors shall have flanged or threaded end connections to match equipment connected and shall be capable of 3/4-inch (20-mm) misalignment.
- 2.4. **JOINING MATERIALS:**
  - 2.4.1. Welding Materials: Comply with Section II, Part C of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
  - 2.4.2. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.
- 2.5. **VALVES:**
  - 2.5.1. Gate, globe, check, ball, and butterfly valves are specified in Division 15 Section "Valves."
  - 2.5.2. Refer to Part 3 "Valve Applications" Article for specific uses and applications for each valve specified.
- 2.6. **STEAM TRAPS LESS THAN 15 PSIG (100 kPa)**
  - 2.6.1. Thermostatic Traps: Cast-brass, angle-pattern body with integral union tailpiece and screw-in cap; maximum operating pressure of 25 psig (175 kPa); balanced-pressure, stainless- steel or monel diaphragm or bellows element and renewable, hardened stainless-steel head and seat.
  - 2.6.2. Float and Thermostatic Traps: ASTM A 278 (ASTM A 278M), Class 30, cast-iron body and bolted cap; renewable, stainless-steel float mechanism with renewable, hardened stainless-steel head and seat; balanced-pressure, thermostatic air vent made with stainless-steel or monel bellows, and stainless-steel head and seat.
  - 2.6.3. Inverted Bucket Traps: ASTM A 278 (ASTM A 278M), Class 30, cast-iron body and cap, pressure rated for 250 psig (1725 kPa); stainless-steel head and seat; stainless-steel valve retainer, lever, and guide pin assembly; brass or stainless- steel bucket.
    - 2.6.3.1. Accessories: Integral stainless-steel inlet strainer within trap body.
- 2.7. **AIR VENTS:**
  - 2.7.1. Quick Vents: Cast-iron or brass body, with balanced- pressure,

stainless-steel or monel thermostatic bellows, and stainless-steel heads and seats.

2.8.     **STRAINERS:**

2.8.1.     Y-Pattern Strainers: Minimum 250-psig (1725-kPa) steam working pressure; cast-iron body conforming to ASTM A 278 (ASTM A 278M), Class 30; Grade 18-8 stainless-steel screen, 20 mesh for 2-inch NPS (DN50) and smaller, and manufacturer recommended perforations for 2-1/2-inch NPS (DN65) and larger; tapped blowoff plug. Threaded connections for 2- inch NPS (DN50) and smaller and flanged connections for 2- 1/2-inch NPS (DN65) and larger.

2.8.2.     Basket Strainers: Minimum 250-psig (1725-kPa) steam working pressure; cast-iron body conforming to ASTM A 278 (ASTM A 278M), Class 30; Grade 18-8 stainless-steel screen; bolted cover; flanged connections.

2.9.     **METERS:**

2.9.1.     Steam Meters: Pipeline sensor of modified venturi design, of stainless-steel construction, for insertion in pipeline between flanges, plus or minus 1 percent accuracy, producing differential pressure proportional to square of flow rate.

2.9.2.     Condensate Meters: Brass body with positive displacement turbine, magnetic coupling counter, union connection, suitable for temperatures up to 200 deg F (93 deg C).

**PART 3. EXECUTION**

3.1.     **PIPE APPLICATIONS LESS THAN 15 PSIG (100 kPa):**

3.1.1.     Steam Piping, 2-Inch NPS (DN50) and Smaller: Schedule 40 steel pipe with threaded joints and Class 125 cast-iron fittings.

3.1.2.     Condensate Piping, 2-Inch NPS (DN50) and Smaller: Schedule 80 steel pipe with threaded joints and Class 125 malleable-iron fittings.

3.2.     **VALVE APPLICATIONS:**

3.2.1.     General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:

3.2.1.1.   Shutoff Duty: Use gate and ball valves.

3.2.1.2.   Throttling Duty: Use globe and ball valves.

3.2.2.     Install shutoff-duty valves at each branch connection to supply mains, at inlet connection to each steam trap, and elsewhere as indicated.

3.2.3.     Vacuum Breakers Less than 15 psig (100 kPa): Class 150 bronze swing check with composition seat.

- 3.2.4. Install angle-pattern globe valves on supply side of each terminal unit, installed within enclosure.
- 3.2.5. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.
- 3.2.6. Install swing check valves as required to control flow direction and to serve as vacuum breakers, except where noted.
- 3.3. **STEAM-TRAP APPLICATIONS LESS THAN 15 PSIG (100 kPa)**
- 3.3.1. Float and Thermostatic Traps: Steam main and riser drip legs, laundry equipment, kitchen equipment, heat exchangers, and coils.
- 3.3.2. Inverted Bucket Traps: Steam main and riser drip legs.
- 3.4. **PIPING INSTALLATIONS:**
- 3.4.1. Install piping according to Division 15 Section "Basic Mechanical Materials and Methods."
- 3.4.2. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- 3.4.3. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4-inch NPS (DN20) ball valve, and short 3/4-inch NPS (DN20) threaded nipple and cap.
- 3.4.4. Install steam supply piping at a uniform grade of 0.2 percent downward in direction of flow.
- 3.4.5. Install steam supply piping at a uniform grade of 0.2 percent upward in direction of flow.
- 3.4.6. Install condensate return piping at a uniform grade of 0.4 percent downward in direction of flow.
- 3.4.7. Reduce pipe sizes using eccentric reducer fitting installed with level side down.
- 3.4.8. Install branch connections to steam mains using 45-degree fittings in main with takeoff out top of main. Use of 90-degree tee fittings is permissible where 45-degree fittings are impractical. Where length of branch takeoff is less than 10 feet (3 m), pitch branch line down toward mains at 0.4 percent slope.
- 3.4.9. Install unions or flanges adjacent to each valve, at final connections of each piece of equipment, and elsewhere as indicated.
- 3.4.10. Install strainers on supply side of each control valve, pressure-regulating valve, solenoid valve, traps, and elsewhere as indicated. Install 3/4-inch NPS (DN20) nipple and ball valve in blow-down connection of strainers 2-inch NPS (DN50) and larger. Match size of strainer blowoff connection.

- 3.4.11. Anchor piping to ensure proper direction of expansion and contraction.
- 3.4.12. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, control valves, isolation valves, pipe bends, and expansion joints.
  - 3.4.12.1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 200 feet (60 m) where pipe is pitched down in direction of steam flow and a maximum of 150 feet (45 m) where pipe is pitched in opposite direction of steam flow.
  - 3.4.12.2. Size drip legs at vertical risers full size and extend beyond rise. Size drip legs at other locations same diameter as main. Provide 18-inch- (450-mm-) long drip leg for steam mains smaller than 6-inch NPS (DN150). In steam mains 6-inch NPS (DN150) and larger, provide drip legs 2 pipe sizes smaller than main, but not less than 4-inch NPS (DN100).
  - 3.4.12.3. Equip drip legs, dirt pockets, and strainer blow-downs with gate valves to allow removal of dirt and scale.
  - 3.4.12.4. Install steam traps close to drip legs.
- 3.5. **STEAM-TRAP INSTALLATION:**
  - 3.5.1. Install steam traps in accessible locations close to connected equipment, maximum 48 inches (1200 mm).
    - 3.5.1.1. Unless otherwise indicated, install gate valve, strainer, and union upstream from trap; install union, check valve, and gate valve downstream from trap.
- 3.6. **HANGERS AND SUPPORTS:**
  - 3.6.1. General: Hanger, support, and anchor devices are specified in Division 15 Section "Hangers and Supports." Conform to requirements below for maximum spacing of supports.
  - 3.6.2. Install the following pipe attachments:
    - 3.6.2.1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) in length.
    - 3.6.2.2. Adjustable roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.
    - 3.6.2.3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal runs 20 feet (6 m) or longer, supported on a trapeze.
    - 3.6.2.4. Spring hangers to support vertical runs.
  - 3.6.3. Install hangers with the following minimum rod sizes and maximum spacing:

- 3.6.3.1. 3/4-Inch NPS (DN20): Maximum span, 7 feet (2.1 m); minimum rod size, 1/4 inch (6.4 mm).
- 3.6.3.2. 1-Inch NPS (DN25): Maximum span, 7 feet (2.1 m); minimum rod size, 1/4 inch (6.4 mm).
- 3.6.4. Support vertical runs at each floor.
- 3.7. **PIPE JOINT CONSTRUCTION:**
  - 3.7.1. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for joint construction requirements for threaded, welded, and flanged joints.
- 3.8. **TERMINAL EQUIPMENT CONNECTIONS:**
  - 3.8.1. Piping size for supply and return shall be same size as equipment connections.
  - 3.8.2. Install traps and control valves in accessible locations close to connected equipment.
  - 3.8.3. Install bypass piping with globe valve around control valve. Where multiple, parallel control valves are installed, only one bypass is required.
  - 3.8.4. Install vacuum breaker downstream from control valve and bypass, and close to coil inlet connection.
  - 3.8.5. Install pressure gages at coil inlet connections.
  - 3.8.6. Pipe outlet from coils to drip leg. From drip leg, install an appropriate trap, sized at 3 times the condensate load of equipment, at 1/2-psig (3.5-kPa) differential.
- 3.9. **FIELD QUALITY CONTROL:**
  - 3.9.1. Testing Preparation: Prepare steam and condensate piping according to ASME B31.9 and as follows:
    - 3.9.1.1. Leave joints, including welds, uninsulated and exposed for examination during test.
    - 3.9.1.2. Flush system with clean water. Clean strainers.
    - 3.9.1.3. Isolate equipment that is not subjected to test pressure from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Flanged joints where blinds are inserted to isolate equipment need not be tested.
    - 3.9.1.4. Install relief valve set at a pressure no more than one- third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
  - 3.9.2. Testing: Test steam and condensate piping as follows:

- 3.9.2.1. Use ambient temperature water as testing medium, except where there is risk of damage due to freezing. Another liquid may be used if it is safe for workers and compatible with piping system components.
- 3.9.2.2. Use traps installed at the high points of system to release trapped air while filling system. Use drip legs installed at low points for complete removal of liquid.
- 3.9.2.3. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Check to verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, Code for Pressure Piping, "Building Services Piping."
- 3.9.2.4. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.
- 3.9.2.5. Prepare written report of testing.
- 3.10. **CLEANING:**
- 3.10.1. After completing system installation, including outlet fittings and devices, inspect finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
- 3.10.2. Flush steam and condensate piping with clean water. Remove, clean, and replace strainer screens.

## **SECTION 15540 - HVAC PUMPS**

### **PART 1. - GENERAL**

#### **1.1. SUMMARY**

1.1.1. This Section includes the following categories of HVAC pumps for hydronic systems:

1.1.1.1. Vertical in-line pumps.

#### **1.2. PERFORMANCE REQUIREMENTS**

1.2.1. Pump Pressure Ratings: At least equal to system's maximum operating pressure at point where installed, but not less than specified.

#### **1.3. SUBMITTALS**

1.3.1. Product data including certified performance curves and rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories. Indicate pump's operating point on curves.

#### **1.4. QUALITY ASSURANCE**

1.4.1. Regulatory Requirements: Comply with provisions of the following:

1.4.1.1. ASME B31.9 "Building Services Piping" for piping materials and installation.

1.4.1.2. Hydraulic Institute's "Standards for Centrifugal, Rotary & Reciprocating Pumps" for pump design, manufacture, testing, and installation.

1.4.1.3. UL 778 "Standard for Motor Operated Water Pumps" for construction requirements. Include UL listing and labeling.

1.4.1.4. NEMA MG 1 "Standard for Motors and Generators" for electric motors. Include NEMA listing and labeling.

1.4.1.5. NFPA 70 "National Electrical Code" for electrical components and installation.

1.4.2. Product Options: Drawings indicate sizes, profiles, connections, and dimensional requirements of pumps and are based on the specific types and models indicated. Other manufacturers' pumps with equal performance characteristics may be considered.

#### **1.5. DELIVERY, STORAGE, AND HANDLING**

1.5.1. Store pumps in dry location.

- 1.5.2. Retain shipping flange protective covers and protective coatings during storage.
- 1.5.3. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- 1.5.4. Extended Storage Longer than 5 Days: Dry internal parts with hot air or vacuum-producing device. Coat internal parts with light oil, kerosene, or antifreeze after drying. Dismantle bearings and couplings; dry; coat with acid-free, heavy oil; tag; and store in dry location.
- 1.5.5. Comply with pump manufacturer's rigging instructions.

## **PART 2. PRODUCTS**

### **2.1. MANUFACTURERS**

- 2.1.1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
  - 2.1.1.1. Vertical In-Line Pumps:
    - 2.1.1.1.1. Allis-Chalmers Fluid Products Co.; Industrial Pump Div.
    - 2.1.1.1.2. Amtrol, Inc.
    - 2.1.1.1.3. Armstrong Pumps, Inc.
    - 2.1.1.1.4. Burks Pumps, Inc.; Weinman Pump.
    - 2.1.1.1.5. Crane Co.; Deming Pump Co. Div.
    - 2.1.1.1.6. Darling Duro, Ltd.
    - 2.1.1.1.7. Dunham-Bush, Inc.
    - 2.1.1.1.8. Federal Pump Corp.
    - 2.1.1.1.9. General Signal; Aurora Pump.
    - 2.1.1.1.10. Grundfos Pumps Corp.
    - 2.1.1.1.11. ITT Fluid Technology Corp.; Bell & Gossett Div.
    - 2.1.1.1.12. Paco Pumps, Inc.
    - 2.1.1.1.13. Patterson Pump Co.
    - 2.1.1.1.14. Peerless Pump Co.
    - 2.1.1.1.15. Taco, Inc.

2.2. **PUMPS, GENERAL**

- 2.2.1. General: Factory assembled and tested.
- 2.2.2. Types, Sizes, Capacities, and Characteristics: As indicated.
- 2.2.3. Motors: NEMA MG 1, general purpose, continuous duty, Design B, except Design C where required for high starting torque. Furnish single-, multiple-, or variable-speed motors, with type of enclosures and electrical characteristics indicated. Include built-in thermal- overload protection and grease-lubricated ball bearings. Select each motor to be nonoverloading over full range of pump performance curve.
- 2.2.4. Motors Indicated to Be Energy Efficient: Minimum efficiency as indicated according to IEEE 112, Test Method B. Include motors with higher efficiency than "average standard industry motors" according to IEEE 112, Test Method B, if efficiency is not indicated.
- 2.2.5. Factory Finish: Manufacturer's standard paint applied to factory-assembled and -tested units before shipping.
- 2.2.6. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

2.3. **VERTICAL IN-LINE PUMPS**

- 2.3.1. Description: Vertical, in-line, centrifugal, separately coupled, single-stage, radially split case design. Include vertical-mounting, bronze-fitted design and mechanical seals rated for 125-psig (860-kPa) minimum working pressure and a continuous water temperature of 225 deg F (107 deg C). Include the following:
- 2.3.1.1. Casing: Cast iron, with threaded companion flanges for piping connections smaller than 2-1/2 inches (DN65), drain plug in bottom of volute, and threaded gage tappings at inlet and outlet connections.
- 2.3.1.1.1. Connection Option: Include unions, instead of threaded companion flanges, at connections for casings that are not available with threaded companion flanges.
- 2.3.1.2. Impeller: ASTM B 584, cast bronze, statically and dynamically balanced, closed, overhung, single suction, and keyed to shaft.
- 2.3.1.3. Wearing Rings: Replaceable, bronze casing ring.
- 2.3.1.4. Shaft and Sleeve: Ground and polished steel shaft with bronze sleeve and integral thrust bearing. Include flinger on motor shaft between motor and seals to prevent liquid that leaks past pump seals from entering motor bearings.

- 2.3.1.5.     Seals: Mechanical type. Include carbon-steel rotating ring, stainless-steel spring, ceramic seat, and flexible bellows and gasket.
- 2.3.1.6.     Seals: Stuffing-box type. Include at least 4 rings of graphite-impregnated braided yarn with bronze lantern ring between center 2 graphite rings, and bronze packing gland.
- 2.3.1.7.     Motor: Direct mounted to pump casing. Include lifting and supporting lugs in top of motor enclosure.

### **PART 3. - EXECUTION**

#### **3.1.       EXAMINATION**

- 3.1.1.       Examine areas, equipment foundations, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting performance of pumps.
- 3.1.2.       Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- 3.1.3.       Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- 3.1.4.       Do not proceed until unsatisfactory conditions have been corrected.

#### **3.2.       INSTALLATION**

- 3.2.1.       Install pumps according to manufacturer's written installation and alignment instructions.
- 3.2.2.       Install pumps in locations indicated and arranged to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.
- 3.2.3.       Support pumps and piping separately so that piping is not supported by pumps.
- 3.2.4.       Suspend in-line pumps using continuous-thread hanger rod and vibration-isolation hangers of sufficient size to support weight of pump independent of piping system.

#### **3.3.       CONNECTIONS**

- 3.3.1.       General: Install shutoff valve and strainer on pump suction and check valve and shutoff valve on pump discharge, except where other arrangement is indicated.
- 3.3.2.       Connect piping to pumps as indicated. Install valves that are the same size as piping connecting to pumps.
- 3.3.3.       Install suction and discharge pipe sizes equal to or greater than

the diameter of pump nozzles.

- 3.3.4. Install nonslam check valve and globe valve on discharge side of vertical in-line pumps.
- 3.3.5. Install triple-duty valve on discharge side of vertical in- line pumps.
- 3.3.6. Install thermometers where indicated.
- 3.3.7. Install pressure gages on pump suction and discharge. Install at integral pressure gage tapings where provided.
- 3.3.8. Install temperature and pressure gage connector plugs in suction and discharge piping around each pump.
- 3.3.9. Install check valve and gate or ball valve on each condensate pump unit discharge.
- 3.3.10. Install electrical connections for power, controls, and devices.
- 3.3.11. Electrical power and control wiring and connections are specified in Division 16 Sections.

3.4. **FIELD QUALITY CONTROL**

- 3.4.1. Check suction piping connections for tightness to avoid drawing air into pumps.
- 3.4.2. Clean strainers.
- 3.4.3. Set pump controls.

3.5. **COMMISSIONING**

- 3.5.1. Final Checks Before Startup: Perform the following preventive maintenance operations and checks before startup:
  - 3.5.1.1. Lubricate bearings.
  - 3.5.1.2. Remove grease-lubricated bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's recommendations.
  - 3.5.1.3. Disconnect coupling and check motor for proper rotation that matches direction marked on pump casing.
  - 3.5.1.4. Check that pumps are free to rotate by hand. Pumps for handling hot liquids shall be free to rotate with pump hot and cold. Do not operate pump if it is bound or even drags slightly until cause of trouble is determined and corrected.
  - 3.5.1.5. Check that pump controls are correct for required application.
- 3.5.2. Starting procedure for pumps with shutoff power not exceeding safe motor power:

- 3.5.2.1. Prime pumps, opening suction valve, closing drains, and preparing pumps for operation.
- 3.5.2.2. Open cooling water supply valves in cooling water supply to bearings, where applicable.
- 3.5.2.3. Open cooling water supply valves if stuffing boxes are water-cooled.
- 3.5.2.4. Open sealing liquid supply valves if pumps are so fitted.
- 3.5.2.5. Open warm-up valves of pumps handling hot liquids if pumps are not normally kept at operating temperature.
- 3.5.2.6. Open circulating line valves if pumps should not be operated against dead shutoff.
- 3.5.2.7. Start motors.
- 3.5.2.8. Open discharge valves slowly.
- 3.5.2.9. Observe leakage from stuffing boxes and adjust sealing liquid valve for proper flow to ensure lubrication of packing. Let packing "run in" before reducing leakage through stuffing boxes; then tighten glands.
- 3.5.2.10. Check general mechanical operation of pumps and motors.
- 3.5.2.11. Close circulating line valves once there is sufficient flow through pumps to prevent overheating.
- 3.5.3. When pumps are to be started against closed check valves with discharge shutoff valves open, steps are the same, except that discharge valves are opened sometime before motors are started.
- 3.5.4. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

## **SECTION 15683 - RECIPROCATING CHILLERS**

### **PART 1. GENERAL**

#### **1.1. SUMMARY:**

1.1.1. This Section includes reciprocating chillers.

#### **1.2. SUBMITTALS:**

1.2.1. Product data for each chiller including the following:

1.2.1.1. Refrigerant.

1.2.1.2. Capacity.

1.2.1.3. Cooler pressure drop.

1.2.1.4. Weights (shipping, installed, and operating).

1.2.1.5. Furnished accessories.

1.2.1.6. Installation and startup instructions.

1.2.2. Shop drawings detailing fabrication and installation of chiller, including plans, elevations, sections, component details, attachments, and other construction elements. Include the following:

1.2.2.1. Dimensions.

1.2.2.2. Weight loadings and distribution.

1.2.2.3. Clearances for maintenance and operation.

1.2.2.4. Size and location of field connections.

1.2.3. Maintenance data for each chiller to include in the operating and maintenance manual specified in Division 1.

#### **1.3. QUALITY ASSURANCE:**

1.3.1. Manufacturer Qualifications: Firm experienced in manufacturing reciprocating chillers similar to those indicated for this Project and that have a record of successful in-service performance.

1.3.2. Installer Qualifications: Engage an experienced Installer who has successfully installed reciprocating chillers.

1.3.3. ARI Compliance: Conform to ARI 590 for chiller ratings.

1.3.4. ASHRAE Compliance: Conform to ASHRAE 15 for chiller design, construction, leak testing, and installation.

- 1.3.5. ASME Compliance: Comply with ASME "Boiler and Pressure Vessel Code," Section VIII, "Pressure Vessels," Division 1, "Basic Coverage" for constructing and testing cooler pressure vessel. Stamp cooler with ASME mark.
- 1.3.6. NEC Compliance: Comply with applicable NEC requirements pertaining to electrical power and control wiring.
- 1.4. **DELIVERY, STORAGE, AND HANDLING:**
- 1.4.1. Packing and Shipping: Protect chillers from damage by factory packing.
- 1.4.2. Acceptance on Site: Reject any damaged chiller upon arrival.
- 1.4.3. Storage and Protection: Store chillers to prevent damage, and protect from weather, dirt, fumes, water, and construction debris. Provide a clean dry space if available.
- 1.4.4. Handling: Handle chillers according to the manufacturer's rigging and installation instructions for unloading and transporting into the final location.
- 1.5. **WARRANTY:**
- 1.5.1. Written manufacturer's warranty covering parts and labor for compressor or motor failures within a period of 5 years.

## **PART 2. PRODUCTS**

- 2.1. **MANUFACTURERS:**
- 2.1.1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering reciprocating chillers that may be incorporated in the Work include, but are not limited to, the following:
  - 2.1.1.1. Outdoor Air-Cooled Reciprocating Chillers:
    - 2.1.1.1.1. Carrier Corporation, Subsidiary of United Technologies Corp.
    - 2.1.1.1.2. SnyderGeneral Corporation.
    - 2.1.1.1.3. The Trane Company.
    - 2.1.1.1.4. York International Corporation.
- 2.2. **OUTDOOR AIR-COOLED RECIPROCATING CHILLERS:**
- 2.2.1. Compressor Features: Hermetic or serviceable hermetic with the following options:
  - 2.2.1.1. Multiple cylinders.
  - 2.2.1.2. Stepped capacity control.

- 2.2.1.3. Vibration isolators to isolate compressors.
- 2.2.1.4. Crankcase heater.
- 2.2.1.5. Oil strainer.
- 2.2.1.6. Oil sight glass.
- 2.2.1.7. Oil filling connection.
- 2.2.1.8. Reversible, positive-displacement oil pump.
- 2.2.1.9. Oil filter with magnetic plug.
- 2.2.1.10. Suction and discharge line service valves.
- 2.2.2. Refrigerant: R-22 (HCFC-22); full operating charge of refrigerant and oil.
- 2.2.3. Cooler: Direct-expansion shell and tube cooler with the following features:
  - 2.2.3.1. Refrigerant totally enclosed in the tubes; water enclosed by the shell.
  - 2.2.3.2. Seamless copper tubes expanded into tube sheets, with the following internal finish:
    - 2.2.3.2.1. Internal Finish: Smooth.
  - 2.2.3.3. Removable carbon-steel heads.
  - 2.2.3.4. Baffle to ensure oil return.
  - 2.2.3.5. Refrigerant Working Pressure: 225 psig (1560 kPa).
  - 2.2.3.6. Water-Side Working Pressure: 300 psig (2070 kPa).
- 2.2.4. Insulation: Factory-insulate cooler, suction lines, and other surfaces where condensation might occur with flexible elastomeric insulation of the following thickness:
  - 2.2.4.1. Thickness: 1/2 inch (13 mm).
- 2.2.5. Air-Cooled Condenser: Include the following features:
  - 2.2.5.1. Coils: Seamless copper tubing mechanically jointed to aluminum fins.
    - 2.2.5.1.1. Factory leak-test coils.
    - 2.2.5.1.2. Minimum Test Pressure: 425 psig (2930 kPa).
  - 2.2.5.2. Fans: Direct drive, statically and dynamically balanced, with fan guards.

- 2.2.5.3. Fan Motor: 3-phase, inherent overload protection, permanently lubricated bearings.
- 2.2.6. Exterior Casing: Manufacturer's standard equipment casing with the following features:
  - 2.2.6.1. Coated with corrosion-resistant exterior finish.
  - 2.2.6.2. Removable doors or panels for service and inspection of components.
  - 2.2.6.3. Tamperproof guards.
- 2.2.7. Refrigerant Circuit Accessories: Include the following:
  - 2.2.7.1. Solenoid valve in each liquid line.
  - 2.2.7.2. Filter/dryer for each circuit with replaceable core.
  - 2.2.7.3. Sight glass and moisture indicator in each liquid line.
  - 2.2.7.4. Thermal-expansion valve for each circuit.
  - 2.2.7.5. Manual shutoff in each liquid line.
  - 2.2.7.6. Refrigerant charging connection for each circuit.
- 2.2.8. Control Panel: Include the following control features:
  - 2.2.8.1. Low-oil-pressure protection.
  - 2.2.8.2. Evaporator-freeze protection.
  - 2.2.8.3. Return-chilled-water-temperature controller.
  - 2.2.8.4. Chilled water flow protection.
  - 2.2.8.5. Condenser water flow protection.
  - 2.2.8.6. Load limiting.
  - 2.2.8.7. Lead/lag compressor sequencing.
  - 2.2.8.8. Low-ambient-temperature head-pressure control.
  - 2.2.8.9. Low-ambient-temperature time delay.
  - 2.2.8.10. Low-refrigerant-pressure protection.
- 2.2.9. Chiller Options: Include the following:
  - 2.2.9.1. Automatic pump down.
  - 2.2.9.2. Hot gas bypass.
  - 2.2.9.3. Control transformer.

- 2.2.9.4. Electric heat-tracing on cooler.
- 2.2.10. Motor-Protection Features: Include the following:
  - 2.2.10.1. Compressor overcurrent protection.
  - 2.2.10.2. Compressor thermal-overload protection.
  - 2.2.10.3. Single-phasing protection.
- 2.2.11. Power Controls: Combination controller and disconnect with part-wind start.
- 2.2.12. Power Controls: Combination controller and disconnect with across-the-line start.
  - 2.2.12.1. External overload protection.
  - 2.2.12.2. Control circuit fuse.
  - 2.2.12.3. Power terminal block.
- 2.2.13. Vibration Control: Direct isolation (no base) and vibration isolators recommended by manufacturer.

### **PART 3. EXECUTION**

- 3.1. **EXAMINATION:**
  - 3.1.1. Examine areas to receive chillers for compliance with installation tolerances and other conditions affecting chiller performance. Examine proposed route of moving chillers into place and verify that it is free of interferences. Verify piping rough-in locations. Verify branch circuit wiring suitability. Do not proceed with installation until unsatisfactory conditions have been corrected.
  - 3.1.2. Final locations of the chillers on the Drawings are approximate, unless dimensioned. Determine exact locations before roughing-in piping and electrical work.
- 3.2. **INSTALLATION:**
  - 3.2.1. Install and anchor chillers plumb and level.
  - 3.2.2. Insulate cooler, suction lines, and other surfaces where condensation might occur.
  - 3.2.3. Insulate suction lines and other surfaces where condensation might occur.
  - 3.2.4. Maintain manufacturer's recommended clearances for service and maintenance.
  - 3.2.5. Install piping connections, maintaining clearances for service

and maintenance.

- 3.2.6. Install flanged or union connections at chillers.
- 3.2.7. Install flexible pipe connections for chillers mounted on vibration isolators.
- 3.2.8. Install shutoff valves at chiller inlet and outlet connections.
- 3.2.9. Electrical Wiring: Install electrical devices furnished loose by manufacturer, including remote flow switches and remote chiller control panel. Furnish copy of manufacturer's wiring diagram submittal to electrical Installer.
- 3.3. **FIELD QUALITY CONTROL:**
  - 3.3.1. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly of components and installation of chillers, including piping and electrical connections, and to report results in writing.
- 3.4. **CLEANING:**
  - 3.4.1. Clean units using materials and methods recommended by manufacturer.
  - 3.4.2. Clean finishes to remove dust and dirt.
  - 3.4.3. Touch up scratches on unfinished surfaces to restore corrosion resistance.
  - 3.4.4. Touch up scratches on finished surfaces to restore finish.
- 3.5. **DEMONSTRATION:**
  - 3.5.1. Startup Services: Provide factory-authorized service representative to start chillers and to demonstrate and train Base Shop Personnel as specified below.
    - 3.5.1.1. Test and adjust chiller controls and safeties. Lubricate rotating parts. Verify that motor amperage conforms to manufacturer's data.
    - 3.5.1.2. Start chiller and verify performance. Demonstrate operation to Base Shop Personnel.
    - 3.5.1.3. Train Base Shop Personnel on procedures and schedules for startup, shutdown, troubleshooting, servicing, and preventive maintenance.
    - 3.5.1.4. Schedule training with Base Shop Personnel through Contracting Officer's Representative with at least 7 days' notice.
- 3.6. **COMMISSIONING:**
  - 3.6.1. Operate equipment controls and safeties.

3.6.2. Lubricate rotating parts.

3.6.3. Verify that motor amperage complies with manufacturer's data.

## **SECTION 15854 - CENTRAL-STATION AIR-HANDLING UNITS**

### **PART 1. - GENERAL**

#### **1.1. SUMMARY**

- 1.1.1. This Section includes variable-volume, central-station air - handling units with coils for indoor installations.

#### **1.2. SUBMITTALS**

- 1.2.1. Product Data for each central-station air-handling unit specified, including the following:
  - 1.2.1.1. Certified fan-performance curves with system operating conditions indicated.
  - 1.2.1.2. Certified fan-sound power ratings.
  - 1.2.1.3. Certified coil-performance ratings with system operating conditions indicated.
  - 1.2.1.4. Motor ratings and electrical characteristics plus motor and fan accessories.
  - 1.2.1.5. Material gages and finishes.
  - 1.2.1.6. Filters with performance characteristics.
  - 1.2.1.7. Dampers, including housings, linkages, and operators.
- 1.2.2. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.
- 1.2.3. Maintenance data for central-station air-handling units to include in the operation and maintenance manual specified in Division 1 Sections and Division 15 Section "Basic Mechanical Requirements."

#### **1.3. QUALITY ASSURANCE**

- 1.3.1. NFPA Compliance: Central-station air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
- 1.3.2. UL Compliance: Electric coils, along with complete central-station air-handling unit, shall be listed and labeled by UL.
- 1.3.3. ARI Certification: Central-station air-handling units and their components shall be factory tested according to the applicable portions of ARI 430, "Central-Station Air- Handling Units," and

shall be listed and bear the label of the Air-Conditioning and Refrigeration Institute (ARI).

- 1.3.4. Comply with NFPA 70 for components and installation.
- 1.3.5. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.
  - 1.3.5.1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
  - 1.3.5.2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- 1.3.6. Coordination: Coordinate layout and installation of central-station air-handling units with piping and ductwork and with other installations.
- 1.4. **DELIVERY, STORAGE, AND HANDLING**
  - 1.4.1. Deliver air-handling unit as a factory-assembled module with protective crating and covering.
  - 1.4.2. Lift and support units with manufacturer's designated lifting or supporting points.
- 1.5. **SEQUENCING AND SCHEDULING**
  - 1.5.1. Coordinate size and location of concrete housekeeping bases. Cast anchor-bolt inserts into base.
  - 1.5.2. Coordinate size and location of structural-steel support members.
- 1.6. **EXTRA MATERIALS**
  - 1.6.1. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
  - 1.6.2. Filters: Furnish 1 set for each central-station air- handling unit.
  - 1.6.3. Fan Belts: Furnish 1 set for each central-station air- handling unit fan.
  - 1.6.4. Gaskets: Furnish 1 for each sectional joint of each central-station air-handling unit.

## **PART 2. - PRODUCTS**

- 2.1. **MANUFACTURERS**
  - 2.1.1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the

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following:

- 2.1.1.1. Carrier Corp.; Carrier Air Conditioning Div.
- 2.1.1.2. SnyderGeneral Corp.; McQuay Commercial Products Group.
- 2.1.1.3. Trane Company (The); Commercial Systems Group.
- 2.1.1.4. York International Corporation.

2.2. **MANUFACTURED UNITS**

- 2.2.1. General Description: Factory assembled, consisting of fans, motor and drive assembly, coils, damper, plenums, filters, drip pans, and mixing dampers.

2.3. **CABINET**

- 2.3.1. Materials: Formed and reinforced galvanized steel panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
  - 2.3.1.1. Outside Casing: Galvanized steel, 0.0635 inch (1.61 mm).
  - 2.3.1.2. Inside Casing: Galvanized steel, 0.0276 inch (0.7 mm).
  - 2.3.1.3. Floor Plate: Galvanized steel, 0.1382 inch (3.5 mm).
- 2.3.2. Insulation: Coated, glass-fiber insulation, complying with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," for insulation.
  - 2.3.2.1. Thickness: 1 inch (25 mm).
  - 2.3.2.2. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from and including the cooling coil section.
- 2.3.3. Access Panels and Doors: Same materials and finishes as cabinet and complete with hinges, latches, handles, and gaskets.
  - 2.3.3.1. Fan section shall have inspection and access panels and doors sized and located to allow periodic maintenance and inspections.
- 2.3.4. Drain Pans: Formed sections of galvanized steel sheet. Fabricate pans in sizes and shapes to collect condensate from cooling coils (including coil piping connections and return bends) and humidifiers when units are operating at maximum catalogued face velocity across cooling coil.
  - 2.3.4.1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
  - 2.3.4.2. Drain Connections: Both ends of pan.
  - 2.3.4.3. Pan-Top Surface Coating: Elastomeric compound.
  - 2.3.4.4. Units with stacked coils shall have an intermediate drain pan or drain trough to collect condensate from top coil.

2.4. **FAN SECTION**

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- 2.4.1. Fan-Section Construction: Belt-driven centrifugal fans, consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure, equipped with formed-steel channel base for integral mounting of fan, motor, and casing panels. Mount fan scroll, wheel, shaft, bearings, and motor on structural- steel frame, with frame mounted on base with vibration isolation.
- 2.4.2. Housings: Fabricate from formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff, spun-metal inlet bell, and access doors or panels to allow entry to internal parts and components.
- 2.4.3. Fan Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor power. Fan wheel shall be double-width, double- inlet type with forward-curved blades or backward-curved airfoil blades as indicated.
  - 2.4.3.1. Backward Inclined: Steel or aluminum construction with curved inlet flange, back plate, backward-curved blades, and cast-iron or cast-steel hub.
  - 2.4.3.2. Forward Curved: Black steel with enamel or galvanized finish, and having an inlet flange, back plate, shallow blades with inlet and tip curved forward in direction of airflow, and steel hub.
  - 2.4.3.3. Airfoil Wheel: Steel; with smooth, curved inlet flange; back plate; die-formed, hollow, airfoil blades; and cast-iron or cast-steel hub.
  - 2.4.3.4. Shafts: Hot-rolled steel; turned, ground, and polished, and having keyway to secure to fan wheel hub.
  - 2.4.3.5. Shaft Bearings: Prelubricated and sealed, self- aligning, pillow-block-type ball or roller bearings with the following:
    - 2.4.3.5.1. Rated Bearing Life: ABMA 9 or ABMA 11, L-50 of 400,000 hours.
  - 2.4.3.6. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
    - 2.4.3.6.1. Service Factor Based on Fan Motor: 1.5.
  - 2.4.3.7. Pulleys: Cast iron or steel with split, tapered bushing, dynamically balanced at factory.
  - 2.4.3.8. Motor Pulleys: Adjustable pitch, selected so pitch adjustment is at middle of adjustment range at fan design conditions.
  - 2.4.3.9. Belts: Oil resistant, nonsparking, and nonstatic; matched for multiple belt drives.
  - 2.4.3.10. Belt Guards: Fabricate to OSHA/SMACNA requirements, 0.1046 inch (2.7 mm) thick, 3/4-inch (20-mm) diamond- mesh wire screen welded

to steel angle frame or equivalent, prime coated.

- 2.4.3.10.1. Provide belt guards for motors mounted on outside of cabinet.
- 2.4.3.11. Motor Mount: Adjustable for belt tensioning.
- 2.4.3.12. Accessories: Provide the following:
  - 2.4.3.12.1. Variable Frequency Drive.
- 2.4.3.13. Vibration Control: Install fans on open-spring vibration isolators, minimum 1-inch (25-mm) static deflection, with side snubbers.
- 2.4.4. Fan-Section Source Quality Control: The following factory tests are required.
  - 2.4.4.1. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
  - 2.4.4.2. Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."
- 2.5. **MOTORS**
  - 2.5.1. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
  - 2.5.2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range.
  - 2.5.3. Temperature Rating: 50 deg C maximum temperature rise at 40 deg C ambient for continuous duty at full load (Class A Insulation).
  - 2.5.4. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors.
  - 2.5.5. Motor Construction: NEMA MG-1, general purpose, continuous duty, Design B.
    - 2.5.5.1. Bases: Adjustable.
  - 2.5.6. Bearings: The following features are required:
    - 2.5.6.1. Ball or roller bearings with inner and outer shaft seals.
    - 2.5.6.2. Grease lubricated.
    - 2.5.6.3. Designed to resist thrust loading where belt drives or other

drives produce lateral or axial thrust in motor.

- 2.5.7. Enclosure Type: The following features are required:
  - 2.5.7.1. Open dripproof motors where satisfactorily housed or remotely located during operation.
  - 2.5.7.2. Guarded dripproof motors where exposed to contact by employees or building occupants.
- 2.5.8. Overload Protection: Built-in, automatic reset, thermal overload protection.
- 2.5.9. Noise Rating: Quiet.
- 2.5.10. Efficiency: Energy-efficient motors shall have a minimum efficiency as scheduled according to IEEE 112, Test Method B. If efficiency is not specified, motors shall have a higher efficiency than "average standard industry motors" according to IEEE 112, Test Method B.
- 2.5.11. Nameplate: Indicate full identification of manufacturer, ratings, characteristics, construction, and special features.
- 2.5.12. Starters, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 16 Sections.
- 2.6. **COILS**
  - 2.6.1. Coil Sections: Common or individual, insulated, galvanized steel casings for heating and cooling coils. Design and construct to facilitate removal and replacement of coil for maintenance and to assure full airflow through coils.
  - 2.6.2. Coil Construction: Rigidly supported across full face, pitched to allow drainage.
    - 2.6.2.1. Fins: Aluminum, mechanically bonded to tubes.
    - 2.6.2.2. Tubes: Seamless copper.
    - 2.6.2.3. Coil Casing: Galvanized steel.
    - 2.6.2.4. Headers for Steam and Water Coils: Steel, cast iron, or copper with connections for drain valve and air vent, and threaded piping connections.
  - 2.6.3. Water Coils: Drainable with threaded plugs, serpentine with return bends in smaller sizes and with return headers in larger sizes.
    - 2.6.3.1. Control Panel: NEMA 250, Type 1 enclosure, with thermal cutouts, primary and secondary controls, back-up contactors, circuit fusing, airflow switch, and fused control transformer. Include integral primary automatic and secondary manual reset thermal-protection devices and airflow switches.

- 2.6.3.2. Controls: Refer to Division 15 Section "Sequence of Operation."
- 2.6.4. Coil-Performance Tests: Factory-test cooling and heating coils, except sprayed surface coils for rating according to ARI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils."
- 2.7. **DAMPERS**
  - 2.7.1. General: Leakage rate, according to AMCA 500, "Test Methods for Louvers, Dampers and Shutters," shall not exceed 2 percent of air quantity at 2000-fpm (10-m/s) face velocity through damper and 4-inch wg (1000-Pa) pressure differential.
    - 2.7.1.1. Damper operators are specified in Division 15 Section "Control Systems Equipment."
  - 2.7.2. Combination Filter/Mixing Box: Parallel-blade galvanized steel damper blades mechanically fastened to steel operating rod in reinforced, galvanized steel cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously. Cabinet support members shall hold 2-inch- (50-mm-) thick, pleated, flat permanent or throwaway filters. Provide hinged access panels or doors to allow removal of filters from both sides of unit.
- 2.8. **FILTER SECTION**
  - 2.8.1. Filters: Comply with NFPA 90A.
  - 2.8.2. Filter Section: Provide filter media holding frames arranged for flat or angular orientation, with access doors on both sides of unit.
  - 2.8.3. Disposable Filters: 2-inch- (50-mm-) thick, viscous-coated fibers encased in fiberboard cell with perforated-metal media support, clean airflow resistance of 0.10 inch wg (25 Pa) at face velocity of 300 fpm (1.52 m/s) and ASHRAE 52.1 filter-arrestance efficiency of 70 to 82 percent.

### **PART 3. - EXECUTION**

- 3.1. **EXAMINATION**
  - 3.1.1. Examine areas and conditions to receive equipment, for compliance with installation tolerances and other conditions affecting performance of central-station air-handling units.
  - 3.1.2. Examine roughing-in of steam, hydronic, condensate drainage piping, and electrical to verify actual locations of connections before installation.
  - 3.1.3. Do not proceed with installation until unsatisfactory conditions have been corrected.
- 3.2. **INSTALLATION**

- 3.2.1. Install central-station air-handling units level and plumb, according to manufacturer's written instructions.
- 3.2.1.1. Floor-Mounted Units: Support on concrete housekeeping bases using neoprene pads. Secure units to anchor bolts installed in concrete housekeeping base.
- 3.2.2. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- 3.3. **HOUSEKEEPING BASES**
- 3.3.1. Coordinate size of housekeeping bases with actual unit sizes provided. Construct base 4 inches (100 mm) larger in both directions than overall dimensions of supported unit.
- 3.4. **CONNECTIONS**
- 3.4.1. Piping installation requirements are specified in other Division 15 Sections. The Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
  - 3.4.1.1. Install piping adjacent to machine to allow service and maintenance.
  - 3.4.1.2. Connection piping to air-handling units with flexible connectors.
  - 3.4.1.3. Connect condensate drain pans using 1-1/4-inch NPS (DN32), Type M copper tubing. Extend to nearest floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
  - 3.4.1.4. Chilled-Water Piping: Conform to applicable requirements of Division 15 Section "Hydronic Piping." Connect to supply and return coil tapings with shutoff or balancing valve and union or flange at each connection.
- 3.4.2. Duct installation and connection requirements are specified in other Division 15 Sections. The Drawings indicate the general arrangement of ducts and duct accessories. Make final duct connections with flexible connections.
- 3.4.3. Electrical: Conform to applicable requirements of Division 16 Sections.
  - 3.4.3.1. Connect fan motors to wiring systems and to ground. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
  - 3.4.3.2. Temperature control wiring and interlock wiring is specified in Division 15 Section "Control Systems Equipment."
- 3.5. **ADJUSTING**

- 3.5.1. Adjust damper linkages for proper damper operation.
- 3.6. **CLEANING**
  - 3.6.1. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
  - 3.6.2. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.
- 3.7. **COMMISSIONING**
  - 3.7.1. Manufacturer's Field Inspection: Engage a factory- authorized service representative to perform the following:
    - 3.7.1.1. Inspect field assembly of components and installation of central-station air-handling units including piping, ductwork, and electrical connections.
    - 3.7.1.2. Prepare a written report on findings and recommended corrective actions.
  - 3.7.2. Final Checks before Startup: Perform the following before startup:
    - 3.7.2.1. Verify that shipping, blocking, and bracing are removed.
    - 3.7.2.2. Verify that unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnects.
    - 3.7.2.3. Perform cleaning and adjusting specified in this Section.
    - 3.7.2.4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
    - 3.7.2.5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
    - 3.7.2.6. Set outside-air and return-air mixing dampers to minimum outside-air setting.
    - 3.7.2.7. Comb coil fins for parallel orientation.
    - 3.7.2.8. Install clean filters.
    - 3.7.2.9. Verify that manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in fully open position.

- 3.7.3. Starting procedures for central-station air-handling units include the following:
  - 3.7.3.1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
    - 3.7.3.1.1. Replace fan and motor pulleys as required to achieve design conditions.
  - 3.7.3.2. Measure and record motor electrical values for voltage and amperage.
  - 3.7.3.3. Manually operate dampers from fully closed to fully open position and record fan performance.
- 3.7.4. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for air-handling system testing, adjusting, and balancing.
- 3.8. **DEMONSTRATION**
  - 3.8.1. Engage the services of a factory-authorized service representative to train Base Shop Personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
    - 3.8.1.1. Schedule training with Base Shop Personnel, through Contracting Officer's Representative with at least 7 days' advance notice.

## **SECTION 15886 - AIR FILTERS**

### **PART 1. GENERAL**

#### **1.1. SUMMARY:**

1.1.1. This Section includes the following types of air filters and accessories:

1.1.1.1. Cleanable (washable) panel filters.

#### **1.2. SUBMITTALS:**

1.2.1. Product data including dimensions, weights, required clearances and access, flow capacity including initial and final pressure drop at rated air flow, efficiency and test method, and fire classification.

#### **1.3. QUALITY ASSURANCE:**

1.3.1. Fire Performance Characteristics: Provide filters identical with those tested for the fire performance characteristics indicated. Identify with appropriate markings of applicable testing and inspecting agency.

1.3.1.1. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

1.3.2. NFPA Compliance: Comply with applicable portions of NFPA 90A and 90B pertaining to installing air filters.

1.3.3. ASHRAE Compliance: Comply with provisions of ASHRAE Standard 52 for method of testing and rating air filter units.

1.3.4. ARI Compliance: Comply with provisions of ARI Standard 850 pertaining to testing and performance of air filter units.

#### **1.4. DELIVERY, STORAGE, AND HANDLING:**

1.4.1. Lift and support factory-assembled units only at designated lifting or supporting points, as indicated on shop drawings. Deliver with protective crating and covering.

### **PART 2. PRODUCTS**

#### **2.1. MANUFACTURERS:**

2.1.1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

2.1.1.0.1. American Air Filter Co.

- 2.1.1.0.2. Farr Co.
- 2.1.1.0.3. Flanders Filters Inc.
- 2.1.1.1. Filter Gages:
  - 2.1.1.1.1. Cambridge Filter Corp.
  - 2.1.1.1.2. Dwyer Instruments, Inc.
- 2.2. **CLEANABLE (WASHABLE) PANEL FILTERS:**
  - 2.2.1. Description: Factory-fabricated, flat-panel type, cleanable air filters with holding frames in sizes and having performance characteristics as indicated.
  - 2.2.2. Media: Cleanable, constructed of woven and crimped aluminum screening, rod reinforced, with aluminum frame.
  - 2.2.3. Duct Holding Frames: 18-gage (1.3mm) galvanized steel and capable of holding media and media frame in place, with gaskets to prevent unfiltered air bypass.

### **PART 3. EXECUTION**

- 3.1. **INSTALLATION:**
  - 3.1.1. Install air filters and holding devices of types indicated and where shown following air filter manufacturer's written instructions and with recognized industry practices to ensure that filters comply with requirements and serve intended purposes.
  - 3.1.2. Locate each filter unit accurately in position indicated in relation to other work. Position unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
  - 3.1.3. Install filters in position to prevent passage of unfiltered air.
    - 3.1.3.1. Install filter gage static-pressure tips upstream and downstream of filters to indicate air pressure drop through filter. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.
- 3.2. **CONNECTIONS:**
  - 3.2.1. Coordinate filter installations with duct and air-handling unit installations.
- 3.3. **CLEANING:**
  - 3.3.1. After testing, adjusting, and balancing air-handling and air-

distribution systems, clean filter housings and install new filter media.

## **SECTION 15891 - METAL DUCTWORK**

### **PART 1. GENERAL**

#### **1.1. SUMMARY:**

- 1.1.1. This Section includes rectangular, metal ducts and plenums for heating, ventilating, and air conditioning systems in pressure classes from minus 1 inch to plus 3 inch water gage.

#### **1.2. DEFINITIONS:**

- 1.2.1. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:
  - 1.2.1.1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
  - 1.2.1.2. Joints: Joints include girth joints; branch and subbranch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

#### **1.3. SYSTEM PERFORMANCE REQUIREMENTS:**

- 1.3.1. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

#### **1.4. SUBMITTALS:**

- 1.4.1. Shop drawings from duct fabrication shop, drawn to a scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as the Contract Drawings, detailing:
  - 1.4.1.1. Duct layout, indicating pressure classifications and sizes in plan view.
  - 1.4.1.2. Fittings.
  - 1.4.1.3. Reinforcing details and spacing.
  - 1.4.1.4. Seam and joint construction details.

- 1.4.1.5. Penetrations through fire-rated and other partitions.
- 1.4.1.6. Terminal unit installation.
- 1.4.1.7. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
- 1.5. **QUALITY ASSURANCE:**
  - 1.5.1. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel" for hangers and supports and AWS D9.1 "Sheet Metal Welding Code."
  - 1.5.2. Qualify each welder in accordance with AWS qualification tests for welding processes involved. Certify that their qualification is current.
  - 1.5.3. NFPA Compliance: Comply with the following NFPA Standards:
    - 1.5.3.1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.
- 1.6. **DELIVERY, STORAGE, AND HANDLING:**
  - 1.6.1. Deliver sealant and fire-stopping materials to site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
  - 1.6.2. Store and handle sealant fire-stopping materials in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

## **PART 2. PRODUCTS**

- 2.1. **SHEET METAL MATERIALS:**
  - 2.1.1. Sheet Metal, General: Provide sheet metal in thicknesses indicated, packaged and marked as specified in ASTM A 700.
  - 2.1.2. Galvanized Sheet Steel: Lock-forming quality, ASTM A 527, Coating Designation G 90. Provide mill phosphatized finish for exposed surfaces of ducts exposed to view.
- 2.2. **FIRE-STOPPING:**
  - 2.2.1. Fire-Resistant Sealant: Provide two-part, foamed-in-place, fire-stopping silicone sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies

per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

2.2.2. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

2.2.2.1. "Dow Corning Fire Stop Foam"; Dow Corning Corp.

2.2.2.2. "Pensil 851"; General Electric Co.

2.3. **HANGERS AND SUPPORTS:**

2.3.1. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concretes or for slabs less than 4 inches thick.

2.3.2. Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod.

2.3.2.1. Hangers Installed In Corrosive Atmospheres: Electro- galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.

2.3.2.2. Straps and Rod Sizes: Conform with Table 4-1 in SMACNA HVAC Duct Construction Standards, 1985 Edition, for sheet steel width and gage and steel rod diameters.

2.3.3. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

2.4. **RECTANGULAR DUCT FABRICATION:**

2.4.1. General: Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, in accordance with SMACNA "HVAC Duct Construction Standards," Tables 1-3 through 1-19, including their associated details. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications, and joint types and intervals.

2.4.1.1. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.

2.4.1.2. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

2.4.2. Static Pressure Classifications: Except where otherwise indicated, construct duct systems to the following pressure classifications:

2.4.2.1. Supply Ducts: 3 inch water gage.

- 2.4.2.2. Return Ducts: 1 inch water gage, negative pressure.
- 2.4.3. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20 gage or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standard," Figure 1-4, unless they are lined or are externally insulated.
- 2.5. **RECTANGULAR DUCT FITTINGS:**
- 2.5.1. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," 1985 Edition, Figures 2-1 through 2-10.

### **PART 3. EXECUTION**

- 3.1. **DUCT INSTALLATION, GENERAL:**
- 3.1.1. Duct System Pressure Class: Construct and install each duct system for the specific duct pressure classification indicated.
- 3.1.2. Install ducts with the fewest possible joints.
- 3.1.3. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.
- 3.1.4. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.
- 3.1.5. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.
- 3.1.6. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- 3.1.7. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.
- 3.1.8. Install insulated ducts with 1-inch clearance outside of insulation.
- 3.1.9. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- 3.1.10. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on 4

sides by at least 1-1/2 inches.

3.2. **SEAM AND JOINT SEALING:**

- 3.2.1. General: Seal duct seams and joints as follows:
- 3.2.2. Pressure Classification 3 Inch Water Gage: All transverse joints and longitudinal seams.
- 3.2.3. Seal externally insulated ducts prior to insulation installation.

3.3. **HANGING AND SUPPORTING:**

- 3.3.1. Install rectangular, metal duct with support systems indicated in SMACNA "HVAC Duct Construction Standards," Tables 4-1 through 4-3 and Figures 4-1 through 4-8.
- 3.3.2. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.
- 3.3.3. Support vertical ducts at a maximum interval of 16 feet and at each floor.
- 3.3.4. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated.

3.4. **CONNECTIONS:**

- 3.4.1. Equipment Connections: Connect equipment with flexible connectors in accordance with Division 15 Section "Duct Accessories."

3.5. **FIELD QUALITY CONTROL:**

- 3.5.1. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.

3.6. **FIELD QUALITY CONTROL:**

- 3.6.1. Disassemble, reassemble, and seal segments of the systems as required to accommodate leakage testing, and as required for compliance with test requirements.
- 3.6.2. Maximum Allowable Leakage: As described in ASHRAE 1989 Handbook, "Fundamentals" Volume, Chapter 32, Table 6 and Figure 10. Comply with requirements for leakage classification 12 for rectangular ducts in pressure classifications less than and equal to 3 inches water gage (both positive and negative pressures).
- 3.6.3. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.
- 3.6.4. Leakage Test: Perform tests according to SMACNA's "HVAC Air Duct

Leakage Test Manual".

3.7. **CLEANING:**

- 3.7.1. Vacuum ducts systems prior to final acceptance to remove dust and debris.

## **SECTION 15910 - DUCT ACCESSORIES**

### **PART 1. GENERAL**

#### **1.1. SUMMARY:**

1.1.1. This Section includes the following:

1.1.1.1. Turning vanes.

1.1.1.2. Duct-mounted access doors and panels.

1.1.1.3. Flexible connectors.

1.1.1.4. Accessories hardware.

#### **1.2. SUBMITTALS:**

1.2.1. Shop drawings from manufacturer detailing assemblies. Include dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

#### **1.3. QUALITY ASSURANCE:**

1.3.1. NFPA Compliance: Comply with the following NFPA Standards:

1.3.1.1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.3.1.2. NFPA 90B, "Standard for the Installation of Warm Air Heating and Air Conditioning Systems."

### **PART 2. PRODUCTS**

#### **2.1. TURNING VANES:**

2.1.1. Manufactured Turning Vanes: Fabricate of 1-1/2-inch-wide (38-mm-wide), curved blades set at 3/4 inch (19 mm) on center, support with bars perpendicular to blades set at 2 inches (50 mm) on center, and set into side strips suitable for mounting in ducts.

2.1.2. Acoustic Turning Vanes: Fabricate of airfoil-shaped aluminum extrusions with perforated faces and fiber glass fill.

#### **2.2. DUCT-MOUNTED ACCESS DOORS AND PANELS:**

2.2.1. Frame: Galvanized sheet steel. Provide with bend-over tabs and foam gaskets.

2.2.2. Door: Double-wall, galvanized sheet metal construction with insulation fill and thickness, number of hinges and locks as indicated for duct pressure class. Provide vision panel where

indicated. Provide 1-inch by 1-inch (25-mm by 25-mm) butt hinge or piano hinge and cam latches.

- 2.2.3. Seal around frame attachment to duct and door to frame with neoprene or foam rubber seals.
- 2.2.4. Insulation: 1-inch- (25-mm-) thick fiber glass or polystyrene foam board.

2.3. **FLEXIBLE CONNECTORS:**

- 2.3.1. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL Standard 181, Class 1.
- 2.3.2. Standard Metal-Edged Connectors: Factory-fabricated with a strip of fabric 3-1/2 inches (89 mm) wide attached to 2 strips of 2-3/4-inch-wide (70-mm-wide), 24-gage (0.7-mm), galvanized sheet steel or 0.032-inch (0.8-mm) aluminum sheets. Select metal compatible with connected duct system. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA HVAC Duct Standard, 1st Edition, Figure 2-19.
- 2.3.3. Conventional, Outdoor System Flexible Connectors Fabric: Glass fabric double coated with Du Pont's HYPALON or other synthetic-rubber weatherproof coating resistant to the sun's ultraviolet rays and ozone environment.
  - 2.3.3.1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
  - 2.3.3.2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.

2.4. **ACCESSORIES HARDWARE:**

- 2.4.1. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket and a flat mounting gasket. Size to allow insertion of pitot tube and other testing instruments and provide in length to suit duct insulation thickness.
- 2.4.2. Splitter Damper Accessories: Zinc-plated damper blade bracket, 1/4-inch (6-mm), zinc-plated operating rod, and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.
- 2.4.3. Flexible Duct Clamps: Stainless steel band with cadmium-plated hex screw to tighten band with a worm-gear action. Provide in sizes from 3 to 18 inches (75 to 450 mm) to suit duct size.
- 2.4.4. Adhesives: High strength, quick setting, neoprene based, waterproof and resistant to gasoline and grease.

**PART 3. EXECUTION**

- 3.1.       **EXAMINATION:**
- 3.1.1.     Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of duct accessories. Do not proceed with installation until unsatisfactory conditions are corrected.
- 3.2.       **INSTALLATION:**
- 3.2.1.     Install duct accessories according to manufacturer's installation instructions and applicable portions of details of construction as shown in SMACNA standards.
- 3.2.2.     Provide test holes at fan inlet and outlet and elsewhere as indicated.
- 3.3.       **ADJUSTING:**
- 3.3.1.     Adjust duct accessories for proper settings.

## **SECTION 15932 - AIR OUTLETS AND INLETS**

### **PART 1. GENERAL**

#### **1.1. DESCRIPTION OF WORK:**

- 1.1.1. Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this section.
- 1.1.2. Types of outlets and inlets required for project include the following:
  - 1.1.2.1. Ceiling air diffusers.
- 1.1.3. Refer to other Division-15 sections for ductwork and duct accessories required in conjunction with air outlets and inlets; not work of this section.
- 1.1.4. Refer to other Division-15 sections for balancing of air outlets and inlets; not work of this section.

#### **1.2. QUALITY ASSURANCE:**

- 1.2.1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air outlets and inlets of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- 1.2.2. Codes and Standards:
  - 1.2.2.1. ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets".
  - 1.2.2.2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".
  - 1.2.2.3. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

#### **1.3. SUBMITTALS:**

- 1.3.1. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:
  - 1.3.1.1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.
  - 1.3.1.2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
  - 1.3.1.3. Performance data for each type of air outlet and inlet furnished,

including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings. Indicate selections on data.

1.4. **PRODUCT DELIVERY, STORAGE AND HANDLING:**

- 1.4.1. Deliver air outlets and inlets wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.
- 1.4.2. Store air outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

**PART 2. PRODUCTS**

2.1. **CEILING AIR DIFFUSERS:**

- 2.1.1. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- 2.1.2. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- 2.1.3. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.
- 2.1.4. Types: Provide ceiling diffusers to match existing styles.
  - 2.1.4.1. Diffuser Mountings:
    - 2.1.4.1.1. Lay-In (L-I): Diffuser housing sized to fit between ceiling exposed suspension tee bars and rest on top surface of tee bar.
  - 2.1.4.2. Diffuser Patterns:
    - 2.1.4.2.1. Adjustable (ADJ): Manual adjustable core with concentric rings or louvers, fully adjustable for horizontal to vertical air flow.
  - 2.1.4.3. Diffuser Finishes:
    - 2.1.4.3.1. White Enamel (W-E): Semi-gloss white enamel prime finish.

- 2.1.5. Available Manufacturers: Subject to compliance with requirements, manufacturers offering diffusers which may be incorporated in the work include, but are not limited to, the following:
- 2.1.5.1. Carnes Co.; Div. of Wehr Corp.
- 2.1.5.2. Krueger Mfg. Co.
- 2.1.5.3. Titus Products Div.; Philips Industries, Inc.
- 2.1.5.4. Metalaire, Inc.

### **PART 3. EXECUTION**

#### **3.1. INSPECTION:**

- 3.1.1. Examine areas and conditions under which air outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

#### **3.2. INSTALLATION:**

- 3.2.1. General: Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended function.
  - 3.2.2. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.
  - 3.2.3. Locate ceiling air diffusers, registers, and grilles, as indicated on Mechanical Plans.
- #### **3.3. SPARE PARTS:**
- 3.3.1. Furnish to the Government with receipt, 3 operating keys for each type of air outlet and inlet that require them.

## **SECTION 15933 - AIR TERMINALS**

### **PART 1. GENERAL**

#### **1.1. DESCRIPTION OF WORK:**

- 1.1.1. Extent of air terminals work required by this section is indicated on drawings and schedules, and by requirements of this section.
- 1.1.2. Types of air terminals specified in this section include the following:
  - 1.1.2.1. Central Air Terminals
    - 1.1.2.1.1. Shutoff Single Duct
    - 1.1.2.1.2. Reheat
- 1.1.3. Refer to other Division-15 sections for external insulation of air terminals; not work of this section.
- 1.1.4. Refer to other Division-15 sections for testing, adjusting and balancing of air terminals; not work of this section.
- 1.1.5. Refer to other Division-15 sections for temperature controls which are to be furnished by others but installed as work of this section.
- 1.1.6. Refer to Division-16 sections for the following work; not work of this section.
  - 1.1.6.1. Power supply wiring from power source to power connection on air terminals. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

#### **1.2. QUALITY ASSURANCE:**

- 1.2.1. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of air terminals with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- 1.2.2. Codes and Standards: As follows:
  - 1.2.2.1. ADC Compliance: Provide air terminals which have been tested and rated in accordance with ADC standards, and bear ADC Seal.
  - 1.2.2.2. ARI Compliance: Provide air terminals which have been tested and rated in accordance with ARI 880 "Industry Standard for Air Terminals" and bear ARI certification seal.
  - 1.2.2.3. NFPA Compliance: Construct air terminals using acoustical and

thermal insulations complying with NFPA 90A "Air Conditioning and Ventilating Systems".

1.3. **SUBMITTALS:**

- 1.3.1. Product Data: Submit manufacturer's technical product data, including performance data for each size and type of air terminal furnished; schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished; and installation and start-up instructions.

1.4. **DELIVERY, STORAGE, AND HANDLING:**

- 1.4.1. Deliver air terminals wrapped in factory-fabricated fiberboard type containers. Identify on outside of container type of air terminal and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in boxes.
- 1.4.2. Store air terminals in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

**PART 2. - PRODUCTS**

2.1. **ACCEPTABLE MANUFACTURERS:**

- 2.1.1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering air terminals which may be incorporated in the work include; but are not limited to, the following:
- 2.1.1.1. Carnes Co.
- 2.1.1.2. Titus Products Div.; Philips Industries, Inc.
- 2.1.1.3. Metalaire, Inc.
- 2.1.1.4. Tempmaster Corp.
- 2.1.1.5. Redd-i, Inc.

2.2. **AIR TERMINALS:**

- 2.2.1. General: Provide factory-fabricated and tested air terminals as indicated, selected with performance characteristics which match or exceed those indicated on schedule.
- 2.2.2. Casings: Construct of die-cast aluminum or sheet metal of the following minimum thicknesses:

	<u>Steel</u>	<u>Aluminum</u>
Upstream Pressure Side:	24-ga	0.032 inch
Downstream Pressure Side:	26-ga	0.025 inch

- 2.2.2.1. Provide hanger brackets for attachment of supports.
- 2.2.2.2. Linings: Line inside surfaces of casings with lining material to provide acoustic performance, thermal insulation, and to prevent condensation on outside surfaces of casing. Provide minimum thickness of 1/2 inch (13 mm). Secure lining to prevent delamination, sagging, or settling.
- 2.2.2.3. Access: Provide removable panels in casings to permit access to air dampers and other parts requiring service, adjusting, or maintenance.
  - 2.2.2.3.1. Provide airtight gasket and quarter-turn latches.
- 2.2.2.4. Leakage: Construct casings such that when subjected to 0.5 inch w.g. (125 Pa) pressure for low pressure units, and 3.0 inches w.g. (750 Pa) pressure for high pressure units, total leakage does not exceed 4% of specified air flow capacity with outlets sealed and inlets wide open. Construct air dampers such that when subjected to 6.0 inches w.g. (1.5 kPa) inlet pressure with damper closed, total leakage does not exceed 10% of specified air flow capacity.
- 2.2.3. Air Dampers: Construct of materials that cannot corrode, do not require lubrication, nor require periodic servicing. Provide maximum volume dampers, pressure compensated, that are calibrated in cfm, factory- adjusted, and marked for specified air capacities. Provide mechanism to vary air volume thru damper for minimum to maximum, in response from signal from thermostat.
- 2.2.4. Controls: Provide controls accurate to 1.5 deg F (0.8 deg C) and adjustable from 65 deg F (18 deg C) to 85 deg F (29 deg C).
  - 2.2.4.1. Air terminal shall have external damper operator shaft. VAV controller to be mouted on air terminal. The input and digital output shall be 24VAC. Controller shall adapt to an external damper shaft. Controller shall be equal to Siebe Environmental Controls part #MN-FL03T and fully compatable with Barber-Colman Network 8000DDC.
- 2.2.5. Identification: Provide label on each unit indicating Plan Number, cfm range, cfm factory-setting, and calibration curve (if required).
- 2.2.6. Central Air Terminals: Provide the following features and accessories indicated on Drawings and schedule:
  - 2.2.6.1. Electric Heating Coils: Provide heating coils constructed of electric resistance elements in galvanized steel casing with control box and factory- wiring. Provide over-temperature protection and UL- listing as duct heater.
  - 2.2.6.2. Hardware: Provide hardware as detailed and required to complete

ceiling system including unit mounting brackets, trim pieces, alignment channels, return air diffusers, dummy diffusers, etc.

**PART 3. EXECUTION**

**3.1. INSPECTION:**

- 3.1.1. Examine areas and conditions under which air terminals are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

**3.2. INSTALLATION OF AIR TERMINALS:**

- 3.2.1. General: Install air terminals as indicated, and in accordance with manufacturer's installation instructions.
- 3.2.2. Location: Install each unit level and accurately in position indicated in relation to other work; and maintain sufficient clearance for normal service and maintenance, but in no case less than that recommended by manufacturer.
- 3.2.3. Duct Connections: Connect ductwork to air terminals in accordance with Division-15 ductwork sections.

**3.3. FIELD QUALITY CONTROL:**

- 3.3.1. Upon completion of installation and prior to initial operation, test and demonstrate that air terminals, and duct connections to air terminals, are leak-tight.
- 3.3.2. Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.

**3.4. CLEANING:**

- 3.4.1. Clean exposed factory-finished surfaces. Repair any marred or scratched surfaces with manufacturers touch-up paint.

## **SECTION 15975 - CONTROL SYSTEMS EQUIPMENT**

### **PART 1. GENERAL**

#### **1.1. SUMMARY:**

- 1.1.1. This Section includes control equipment for HVAC systems and components.

#### **1.2. SYSTEM DESCRIPTION:**

- 1.2.1. Control system consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories connected to controllers to operate mechanical systems according to sequences of operation indicated or specified. All components must be fully compatible with existing Barber-Colman Network 8000 DDC System in building.

#### **1.3. SUBMITTALS:**

- 1.3.1. Product Data for each type of product specified. Include manufacturer's technical Product Data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, installation instructions, and startup instructions.
- 1.3.2. Shop Drawings containing the following information for each control system:
  - 1.3.2.1. Schematic flow diagram showing fans, pumps, coils, dampers, valves, and control devices.
  - 1.3.2.2. Each control device labeled with setting or adjustable range of control.
  - 1.3.2.3. Diagrams for all required electrical wiring. Clearly differentiate between factory-installed and field-installed wiring.
  - 1.3.2.4. Details of control panel faces, including controls, instruments, and labeling.
  - 1.3.2.5. Written description of sequence of operation.
- 1.3.3. Wiring diagrams detailing wiring for power, signal, and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.

#### **1.4. QUALITY ASSURANCE:**

- 1.4.1. Installer Qualifications: Engage an experienced Installer specializing in control system installations.
- 1.4.2. Manufacturer Qualifications: Engage a firm experienced in manufacturing control systems similar to those indicated for this

Project and that have a record of successful in-service performance.

1.4.3. Startup Personnel Qualifications: Engage specially trained personnel in direct employ of manufacturer of primary temperature control system.

1.4.4. Comply with NFPA 90A.

1.4.5. Comply with NFPA 70.

1.5. **DELIVERY, STORAGE, AND HANDLING:**

1.5.1. Store equipment and materials inside and protected from weather.

**PART 2. PRODUCTS**

2.1. **MANUFACTURERS:**

2.1.1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

2.1.1.1. Electric Control Systems and Components:

2.1.1.1.1. Barber-Coleman Co.; Environmental Controls.

2.1.1.1.2. Honeywell, Inc.; Commercial Buildings Group.

2.1.1.1.3. Johnson Controls, Inc.; Controls Group.

2.1.1.1.4. Landis & Gyr Powers, Inc.

2.1.1.1.5. Robertshaw Controls Co.

2.1.1.1.6. Tour & Andersson Inc.

2.1.1.2. Electronic Control Systems and Components:

2.1.1.2.1. Channel Products Inc.

2.1.1.2.2. DGH Systems, Inc.

2.1.1.2.3. Diversified Electronics, Inc.

2.1.1.2.4. Eaton Corp.; Industrial Controls Div.

2.1.1.2.5. Energyline Systems; Industrial Products Group.

2.1.1.2.6. ICM Corp.

2.1.1.2.7. INTEC Controls, Inc.

2.1.1.2.8. Johnson Controls, Inc.; Controls Group.

- 2.1.1.2.9. Paragon Electric Co., Inc.
- 2.1.1.2.10. RAM Electronics Corp.
- 2.1.1.2.11. Robertshaw Controls Co.; Uni-Line Div.
- 2.1.1.2.12. SSAC Inc.
- 2.1.1.2.13. TCS/BASYS Controls.
- 2.1.1.2.14. Texas Instruments, Inc.; Control Products Div.
- 2.1.1.2.15. Tour & Andersson Inc.

2.2. **ANALOG CONTROLLERS:**

- 2.2.1. Step Controllers: 6-stage or 10-stage type, with heavy-duty switching rated to handle loads, UL listed and operated by electric motor.
- 2.2.2. Electric Outdoor Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range -10 to 70 deg F (-12 to 21 deg C), and single- or, double-pole contacts.
- 2.2.3. Electronic Controllers: Wheatstone bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
  - 2.2.3.1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.
- 2.2.4. Receiver Controllers: Single- or dual-input models with control-point adjustment direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, and authority adjustment. Provide proportional plus integral control mode.
  - 2.2.4.1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal 4 to 20 milliamp.
  - 2.2.4.2. Proportional band shall extend from 2-1/2 to 40 percent of primary sensor span, authority from 10 to 200 percent of primary sensor span.

2.3. **SENSORS:**

- 2.3.1. Electronic Sensors: Vibration and corrosion resistant, for wall, immersion, or duct mounting as required.
  - 2.3.1.1. Resistance Temperature Detectors: Platinum.
    - 2.3.1.1.1. Accuracy: Plus or minus 0.2 percent at calibration point.
    - 2.3.1.1.2. Wire: Twisted, shielded-pair cable.

- 2.3.1.1.3. Insertion Elements in Ducts: Use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (1 sq. m).
- 2.3.1.1.4. Averaging Elements in Ducts: Use where ducts are larger than 9 sq. ft. (1 sq. m) or where prone to stratification, length as required.
- 2.3.1.1.5. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).
- 2.3.1.1.6. Room Sensors: Match room thermostats, locking cover.
- 2.3.1.1.7. Outside Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
- 2.3.1.2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, temperature compensated.
  - 2.3.1.2.1. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
  - 2.3.1.2.2. Output: 4 to 20 mA.
  - 2.3.1.2.3. Building Static-Pressure Range: 0 to 0.25 inch wg (0 to 62 Pa).
  - 2.3.1.2.4. Duct Static-Pressure Range: 0 to 5 inches wg (0 to 1243 Pa).
- 2.3.1.3. Pressure Transmitters: Direct acting for gas, liquid, or steam service, range suitable for system, proportional output 4 to 20 mA.
- 2.3.2. VAV Box discharge temperature sensor: Equal to Siebe Environmental Controls Part Number MN-SDT and fully compatible with Barber Coleman Network 8000 DDC. Sensor shall have 4" to 8" adjustable length.
- 2.4. **THERMOSTATS:**
  - 2.4.0.1. Equip thermostats, which control electric heating loads directly, with OFF position on dial wired to break ungrounded conductors.
  - 2.4.0.2. Dead Band: Maximum 2 deg F (1 deg C).
  - 2.4.1. Low-Voltage Modulating Thermostats: Thermistor.
    - 2.4.1.1. Bulbs in water lines with separate wells of same material as bulb.
    - 2.4.1.2. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit, adequately supported.
    - 2.4.1.3. Scale settings and differential settings are clearly visible and adjustable from front of instrument.

- 2.4.1.4. ON-OFF, remote-bulb thermostats with precision snap switches, with electrical ratings required by application.
- 2.4.1.5. Construct modulating, remote-bulb, potentiometer thermostats so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
- 2.4.2. Room Thermostat Construction: Manufacturer's standard locking covers.
  - 2.4.2.1. Thermometer: Red-reading glass or spiral bimetal.
- 2.4.3. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
- 2.4.4. Airstream Thermostats: 2-pipe, fully proportional, single temperature, with adjustable set point in middle of range and adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.
- 2.4.5. Electric Low-Limit Duct Thermostat: Snap-acting, single- pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches (305 mm) of bulb length is equal to or below set point.
  - 2.4.5.1. Bulb Length: Minimum 20 feet (6 m).
  - 2.4.5.2. Quantity: 1 thermostat for every 20 sq. ft. (1.9 sq. m) of coil surface.
- 2.4.6. Electric High-Limit Duct Thermostat: Snap-acting, single- pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches (305 mm) of bulb length is equal to or above set point.
  - 2.4.6.1. Bulb Length: Minimum 20 feet (6 m).
  - 2.4.6.2. Quantity: 1 thermostat for every 20 sq. ft. (1.9 sq. m) of coil surface.
- 2.5. **ACTUATORS:**
  - 2.5.1. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or 2-position action.
    - 2.5.1.1. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
    - 2.5.1.2. Nonspring-Return Motors for Valves Larger Than 2-1/2 Inches (DN 65): Size for running torque of 150 inch- pounds (16.9

N x m) and breakaway torque of 300 inch- pounds (33.9 N x m).

2.5.1.3. Spring-Return Motors for Valves Larger Than 2-1/2 Inches (64 mm): Size for running and breakaway torque of 150 inch-pounds (16.9 N x m).

2.5.1.4. Nonspring-Return Motors for Dampers Larger Than 25 sq. ft. (2.3 sq. m): Size for running torque of 150 inch- pounds (16.9 N x m) and breakaway torque of 300 inch- pounds (33.9 N x m).

2.5.1.5. Spring-Return Motors for Dampers Larger Than 25 sq. ft. (2.3 sq. m): Size for running and breakaway torque of 150 inch-pounds (16.9 N x m).

2.5.2. Electronic Operators: Select operator for full shutoff at maximum pump differential pressure.

2.6. **CONTROL VALVES:**

2.6.1. Control Valves: Factory fabricated, of type, body material, and pressure class indicated. Where type or body material is not indicated, make selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature rating of piping system.

2.6.2. Globe Pattern: As follows:

2.6.2.1. Up to 2 inches (DN 50): Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.

2.6.2.2. Over 2 inches (DN 50): Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.

2.7. **CONTROL CABLE:**

2.7.1. Electronic Cable for Control Wiring shall be 18AWG T8PE CL3P.

**PART 3. EXECUTION**

3.1. **INSTALLATION:**

3.1.1. Install equipment as indicated to comply with manufacturer's written instructions.

3.1.2. Verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Locate 60 inches (1524 mm) above floor.

3.1.2.1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

3.1.3. Install labels and nameplates to identify control components.

3.2. **ELECTRICAL WIRING AND CONNECTIONS:**

- 3.2.1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
- 3.2.2. Install exposed cable in raceway.
- 3.2.3. Install concealed cable in raceway.
- 3.2.4. Bundle and harness multiconductor instrument cable in place of single cables where a number of cables follow a common path.
- 3.2.5. Fasten flexible conductors, bridging cabinets and doors, neatly along hinge side; protect against abrasion. Tie and support conductors neatly.
- 3.2.6. Number-code or color-code conductors, except local individual room controls, for future identification and servicing of control system.
- 3.2.7. Connect electrical components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque- tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.
- 3.2.8. Connect manual reset limit controls independent of manual control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- 3.2.9. Connect HAND-OFF-AUTO selector switches to override automatic interlock controls when switch is in HAND position.
- 3.3. **COMMISSIONING:**
  - 3.3.1. Manufacturer's Field Services: Provide the services of a factory-authorized service representative to start control systems.
  - 3.3.2. Test and adjust controls and safeties.
  - 3.3.3. Replace damaged or malfunctioning controls and equipment.
  - 3.3.4. Start, test, and adjust control systems.
  - 3.3.5. Demonstrate compliance with requirements.
  - 3.3.6. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.
- 3.4. **DEMONSTRATION:**
  - 3.4.1. Manufacturer's Field Services: Provide the services of a factory-authorized service representative to demonstrate and train Base Shop Personnel as specified below.

- 3.4.1.1. Train Base Shop personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
- 3.4.1.2. Schedule training with Contracting Officer's representative with at least 7 days' notice.
- 3.4.1.3. Provide operator training on data display, alarm and status descriptors, requesting data, execution of commands, and request of logs. Include a minimum of 8 hours' dedicated instructor time on-site.

**SECTION 15976 - VARIABLE FREQUENCY DRIVE**  
**PART 1 - GENERAL**

1.1 **SUMMARY:**

- 1.1.1 This section describes the requirements for the SCR based, solid state adjustable frequency/variable torque drive units.
- 1.1.2 All materials to be provided shall be new and approved for the particular use as identified on the drawings.

1.2 **SUBMITTALS:**

- 1.2.1 Furnish detailed drawings showing construction, dimensions, wiring diagrams, isolation devices to be supplied, installation instructions, and recommended spare part list.
- 1.2.1.1 Incidental items not indicated on the drawings or mentioned in the Specifications that belong to the work described or required to provide a complete system.

**PART 2: PRODUCTS**

2.1 **ADJUSTABLE FREQUENCY VARIABLE TORQUE DRIVES:**

- 2.1.1 Motor drive shall be SCR based, solid state units with U.L. or ETL approval and meeting all applicable provisions of N.E.C. and NEMA. Unit shall be suitable for use with standard, NEMA B squirrel cage induction motors and shall match the motor size. Drive shall have a minimum efficiency of 96% at full motor load. The power circuit shall consist of a SCR Bridge rectifier and variable voltage input DC to AC power inverter. SCR bridge input for 0.95 power factor at full speed.
- 2.1.2 Drives shall include the following features and/or capabilities:
- Enclosure:
- NEMA 1 wall mounted with latest design cover including solid bottom attached to rear housing with hinged door.
- Lockable.
- Baked enamel finish over phosphatized surface.

Output Ratings:

Output Power:

3-phase, 3-wire, 6-step voltage wave form.

DC bus voltage regulated +/- 1%.

Maximum output voltage 208 volts, 3-phase.

Frequency range 1-66 hz.

Frequency deviation +/- 1%.

Motor overload with phase imbalance sensing.

Motor Performance:

Break away torque 110% of rated torque.

Intermittent overload torque 110% of rated torque  
from 0 to full speed.

Speed regulation between minimum speed as set by  
factory representative and 3% of full speed.

Input Power:

480 volts (+5%, -10%), 3-phase, 60 Hz.

Isolation device to limit distortion on electrical  
supply to a maximum of 16,400 voltseconds and a  
maximum distortion factor of 3%, as defined in  
IEEE Standard 519-198, IEEE Grid for Harmonic  
Control and Reactive Compensation of static power  
converters. Above based on minimum line impedance  
of 1%.

Device shall comply with FCC Rule 15, subparagraph  
J relative to levels of radiated and conducted  
radio interference.

Power outage ride-thru for minimum 8 msec.

Control: Vary speed proportionally from (4-20MA)  
input signal.

Set-Up Adjustments:

Adjustable linear acceleration from 2 to 300  
seconds.

Minimum speed 0-65%.

Maximum speed 45-100%.

Maximum voltage (480 VAC) and volts per Hz set at 7.67.

2.2 **PROTECTIVE FEATURES:**

2.2.1 Full function current limit adjustable between 50 and minimum of 110% of rated output current. Drive to automatically reduce speed in attempt to stay below maximum setting.

2.2.2 Instantaneous overload trip at 105% current.

2.2.3 Minimum of 110% torque at maximum full function current limit.

2.2.4 Electronic circuit protection providing orderly shutdown and preventing fuse blowing or component loss under the following abnormal conditions:

Output fault (line-to-line or line-to-ground).

Output single phase, imbalance, or open circuit.

Internal misfire, logic error or short circuit.

Incoming power distribution; Overvoltage, undervoltage or phase loss.

DC bus overvoltage.

Input line fuses.

Inverter drive disconnect switch with door interlock and provision for external padlock. (Disconnects power to the inverter section only)

Automatic restart feature.

Bypass fuses for motor overloads.

2.3 **QUALITY CONTROL:**

2.3.1 Final functional full load test for 24-hours at 40-deg. C. with motor loads. All failures corrected prior to shipment. Submit four (4) copies of test report to Contracting Officer for approval.

2.4 **MAINTAINABILITY:**

2.4.1 Alphabetical code display for first fault

indicator indicating the following fault conditions: external fault, ground fault, low AC line, high AC line, current overload, high buss volts, reverse operation, phase loss, current trip, and over temperature. Controller shall be designed to store fault conditions for future display.

- 2.4.2 Diagnostic LED's shall be provided in the following areas for diagnostic purposes and signal tracing:

All gate driven outputs.

Inverter gate logic signal.

Current limit condition indicator.

Plug connected printed circuit boards.

2.5 **DOOR MOUNTED ITEMS:**

- 2.5.1 Main fused disconnect switch. (Disconnects power to the inverted and bypass section)
- 2.5.2 Local/remote switch.
- 2.5.3 Manual speed potentiometer.
- 2.5.4 Hand-off-auto pushpad switch.
- 2.5.5 Power on indicator light.
- 2.5.6 Digital loadmeter and speedmeter (in %).
- 2.5.7 Digital voltmeter. Calibrated in actual engineering units and not in percent.
- 2.5.8 Digital ammeter. Calibrated in actual engineering units and not in percent.
- 2.5.9 Digital frequency meter. Calibrated in actual engineering units and not percent.
- 2.5.10 Digital kilowatt meter. Calibrated in actual engineering units and not in percent.
- 2.5.11 Fault light.
- 2.5.12 Digital display shall be 3/4"H x 3"L or larger and shall be backlit.

2.6 **REQUIRED MANUFACTURER OPTION PACKAGE:**

- 2.6.1 Shall include:
- 2.6.2 Input fan motor KW as 0-5 VDC signal output.
- 2.6.3 Normally open level contacts for customer use, set to close at 5 Hz.
- 2.6.4 Input line fuses.
- 2.6.5 Digital ammeter display calibrated in engineering units and not in percent.
- 2.6.6 Frequency meter display calibrated in engineering units and not in percent.
- 2.6.7 Kilowatt meter display calibrated in engineering units and not in percent.
- 2.6.8 Automatic bypass feature as described in Section 2.7, with normally open bypass contacts for customer use.
- 2.6.9 One set of spare control and line voltage fuses.
- 2.6.10 Digital motor RPM display calibrated in engineering units for an 1800 nominal RPM motor.
- 2.6.11 0-5 VDC isolated output board for remote speed indications.
- 2.6.12 Elapsed running time meter.
- 2.6.13 Isolated input speed signal board to accept grounded input signal.
- 2.6.14 One set each of Form C: dry contacts for run and fault indication.
- 2.7 **AUTOMATIC BYPASS:**
- 2.7.1 Built-in automatic bypass to transfer operation of the fan motor to the AC line for operation at constant speed with a 2 to 5 minute adjustable time delay. Bypass shall consist of a drive contactor interlocked mechanically with line contactor, 3-phase manual reset overload protection, and all necessary safety devices completely factory wired requiring only power wiring in and out.
- 2.10 **WARRANTY:**
- 2.10.1 The VFD shall be warranted by the manufacturer for a period of 36 months from date of shipment. The

warranty shall include parts, labor, travel cost and living expenses incurred by the manufacturer to provide factory authorized on-site service.

2.11            **MANUFACTURERS:**

2.11.1          Unit shall be manufactured by Graham, Magnatek or equal.

**PART 3: INSTALLATION**

3.1            **VARIABLE FREQUENCY INVERTER:**

3.1.1          Install units in accordance with manufacturer's recommendations.

3.1.2          Contractor shall arrange unit so as to provide required access to equipment.

## **SECTION 15990 - TESTING, ADJUSTING, AND BALANCING**

### **PART 1. GENERAL**

#### **1.1. SUMMARY:**

- 1.1.1. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:
  - 1.1.1.1. Balancing airflow and water flow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
  - 1.1.1.2. Adjusting total HVAC systems to provide indicated quantities.
  - 1.1.1.3. Measuring electrical performance of HVAC equipment.
  - 1.1.1.4. Setting quantitative performance of HVAC equipment.
  - 1.1.1.5. Verifying that automatic control devices are functioning properly.
  - 1.1.1.6. Reporting results of the activities and procedures specified in this Section.
- 1.1.2. Related Sections include the following:
  - 1.1.2.1. Field quality-control testing to verify that workmanship quality for system and equipment installation is specified in system and equipment Sections.

#### **1.2. DEFINITIONS:**

- 1.2.1. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- 1.2.2. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.
- 1.2.3. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- 1.2.4. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- 1.2.5. Report Forms: Test data sheets for recording test data in logical order.
- 1.2.6. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

- 1.2.7. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- 1.2.8. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- 1.2.9. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- 1.2.10. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- 1.2.11. Test: A procedure to determine quantitative performance of a system or equipment.
- 1.2.12. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.
- 1.2.13. AABC: Associated Air Balance Council.
- 1.2.14. AMCA: Air Movement and Control Association.
- 1.2.15. CTI: Cooling Tower Institute.
- 1.2.16. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.
- 1.3. **SUBMITTALS:**
- 1.3.1. Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit 3 copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.
- 1.3.2. Certified Testing, Adjusting, and Balancing Reports: Submit 3 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.
- 1.3.3. Warranty: Submit 3 copies of special warranty specified in the "Warranty" Article below.
- 1.4. **QUALITY ASSURANCE:**
- 1.4.1. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC.
- 1.4.2. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports.

This certification includes the following:

- 1.4.2.1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports. Use Standard Report Form from AABC.
- 1.4.2.2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.
- 1.4.3. Testing, Adjusting, and Balancing Reports: Use testing, adjusting, and balancing Agent's standard forms.
- 1.4.4. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards.
- 1.4.5. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.
- 1.5. **PROJECT CONDITIONS:**
  - 1.5.1. Full Government Occupancy: The Government will occupy the site and existing building during the entire testing, adjusting, and balancing period. Cooperate with the Government during testing, adjusting, and balancing operations to minimize conflicts with the Government's operations.
- 1.6. **COORDINATION:**
  - 1.6.1. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.
  - 1.6.2. Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.
  - 1.6.3. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.
- 1.7. **WARRANTY:**
  - 1.7.1. General Warranty: The national project performance guarantee specified in this Article shall not deprive the Government of other rights the Government may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
  - 1.7.2. National Project Performance Guarantee: Provide a guarantee on AABC'S "National Standards" forms stating that AABC will assist in completing the requirements of the Contract Documents if the

testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:

- 1.7.2.1. The certified Agent has tested and balanced systems according to the Contract Documents.
- 1.7.2.2. Systems are balanced to optimum performance capabilities within design and installation limits.

**PART 2. PRODUCTS** (Not Applicable)

**PART 3. EXECUTION**

3.1. **EXAMINATION:**

- 3.1.1. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.
  - 3.1.1.1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
  - 3.1.1.2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- 3.1.2. Examine approved submittal data of HVAC systems and equipment.
- 3.1.3. Examine project record documents described in Division 1 Section "Project Record Documents."
- 3.1.4. Examine Architect's and Engineer's design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- 3.1.5. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
- 3.1.6. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and

commissioning specified in individual Specification Sections have been performed.

- 3.1.7. Examine system and equipment test reports.
- 3.1.8. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- 3.1.9. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- 3.1.10. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- 3.1.11. Examine terminal units, such as variable-air-volume boxes and mixing boxes, to verify that they are accessible and their controls are connected and functioning.
- 3.1.12. Examine strainers for clean screens and proper perforations.
- 3.1.13. Examine 3-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- 3.1.14. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- 3.1.15. Examine equipment for installation and for properly operating safety interlocks and controls.
- 3.1.16. Examine automatic temperature system components to verify the following:
  - 3.1.16.1. Dampers, valves, and other controlled devices operate by the intended controller.
  - 3.1.16.2. Dampers and valves are in the position indicated by the controller.
  - 3.1.16.3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in mixing boxes, and variable-air-volume terminals.
  - 3.1.16.4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.
  - 3.1.16.5. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.
  - 3.1.16.6. Sensors are located to sense only the intended conditions.

- 3.1.16.7. Sequence of operation for control modes is according to the Contract Documents.
- 3.1.16.8. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
- 3.1.16.9. Interlocked systems are operating.
- 3.1.16.10. Changeover from heating to cooling mode occurs according to design values.
- 3.1.17. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.
- 3.2. **PREPARATION:**
  - 3.2.1. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.
  - 3.2.2. Complete system readiness checks and prepare system readiness reports. Verify the following:
    - 3.2.2.1. Permanent electrical power wiring is complete.
    - 3.2.2.2. Hydronic systems are filled, clean, and free of air.
    - 3.2.2.3. Automatic temperature-control systems are operational.
    - 3.2.2.4. Equipment and duct access doors are securely closed.
    - 3.2.2.5. Balance, smoke, and fire dampers are open.
    - 3.2.2.6. Isolating and balancing valves are open and control valves are operational.
    - 3.2.2.7. Ceilings are installed in critical areas where air- pattern adjustments are required and access to balancing devices is provided.
    - 3.2.2.8. Windows and doors can be closed so design conditions for system operations can be met.
- 3.3. **GENERAL TESTING AND BALANCING PROCEDURES:**
  - 3.3.1. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards and this Section.
  - 3.3.2. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this

Project.

- 3.3.3. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

- 3.4. **FUNDAMENTAL AIR SYSTEMS' BALANCING PROCEDURES:**

- 3.4.1. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- 3.4.2. Prepare schematic diagrams of systems' "as-built" duct layouts.
- 3.4.3. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- 3.4.4. Check the airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- 3.4.5. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- 3.4.6. Verify that motor starters are equipped with properly sized thermal protection.
- 3.4.7. Check dampers for proper position to achieve desired airflow path.
- 3.4.8. Check for airflow blockages.
- 3.4.9. Check condensate drains for proper connections and functioning.
- 3.4.10. Check for proper sealing of air-handling unit components.

- 3.5. **AIR SYSTEMS' BALANCING PROCEDURES:**

- 3.5.1. The procedures in this Article apply to constant-volume supply-, return-, and exhaust-air systems. Additional procedures are required for variable-air-volume, multizone, dual-duct, induction-unit supply-air systems and process exhaust-air systems. These additional procedures are specified in other articles in this Section.
- 3.5.2. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.
  - 3.5.2.1. Measure fan static pressures to determine actual static pressure as follows:
    - 3.5.2.1.1. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.

- 3.5.2.1.2. Measure static pressure directly at the fan outlet or through the flexible connection.
- 3.5.2.1.3. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
- 3.5.2.1.4. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
- 3.5.2.2. Measure static pressure across each air-handling unit component.
- 3.5.2.2.1. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
- 3.5.2.3. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
- 3.5.2.4. Adjust fan speed higher or lower than design. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
- 3.5.2.5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan- speed safety factors. Modulate dampers and measure fan- motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.
- 3.5.3. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.
- 3.5.3.1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
- 3.5.3.1.1. Where sufficient space in submains and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
- 3.5.3.2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submains and branch ducts to design airflows within specified tolerances.
- 3.5.4. Measure terminal outlets and inlets without making adjustments.
- 3.5.4.1. Measure terminal outlets using a direct-reading hood or the outlet manufacturer's written instructions and calculating factors.

- 3.5.5. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.
- 3.5.5.1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.
- 3.5.5.2. Adjust patterns of adjustable outlets for proper distribution without drafts.
- 3.6. **VARIABLE-AIR-VOLUME SYSTEMS' ADDITIONAL PROCEDURES:**
- 3.6.1. Compensating for Diversity: When the total airflow of all terminal units is more than the fan design airflow volume, place a selected number of terminal units at a maximum set- point airflow condition until the total airflow of the terminal units equals the design airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
- 3.6.2. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air- volume systems as follows:
  - 3.6.2.1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full- cooling load.
  - 3.6.2.2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge duct losses.
  - 3.6.2.3. Measure total system airflow. Adjust to within 10 percent of design airflow.
  - 3.6.2.4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use the terminal unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
  - 3.6.2.5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
    - 3.6.2.5.1. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
  - 3.6.2.6. Remeasure the return airflow to the fan while operating at

maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.6.2.7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure adequate static pressure is maintained at the most critical unit.

3.6.2.8. Record the final fan performance data.

3.7. **MOTORS:**

3.7.1. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

3.7.1.1. Manufacturer, model, and serial numbers.

3.7.1.2. Motor horsepower rating.

3.7.1.3. Motor rpm.

3.7.1.4. Efficiency rating if high-efficiency motor.

3.7.1.5. Nameplate and measured voltage, each phase.

3.7.1.6. Nameplate and measured amperage, each phase.

3.7.1.7. Starter thermal-protection-element rating.

3.7.2. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.8. **HEAT-TRANSFER COILS:**

3.8.1. Water Coils: Measure the following data for each coil:

3.8.1.1. Entering- and leaving-water temperatures.

3.8.1.2. Water flow rate.

3.8.1.3. Water pressure drop.

3.8.1.4. Dry-bulb temperatures of entering and leaving air.

3.8.1.5. Wet-bulb temperatures of entering and leaving air for cooling coils designed for less than 7500 cfm (3540 L/s).

3.8.1.6. Airflow.

3.8.1.7. Air pressure drop.

3.8.2. Electric-Heating Coils: Measure the following data for each

coil:

- 3.8.2.1. Nameplate data.
- 3.8.2.2. Airflow.
- 3.8.2.3. Entering- and leaving-air temperatures at full load.
- 3.8.2.4. Voltage and amperage input of each phase at full load and at each incremental stage.
- 3.8.2.5. Calculated kW at full load.
- 3.8.2.6. Fuse or circuit-breaker rating for overload protection.

3.9. **TEMPERATURE TESTING:**

- 3.9.1. During testing, adjusting, and balancing, report need for adjustment in temperature regulation within the automatic temperature-control system.
- 3.9.2. Measure indoor wet- and dry-bulb temperatures every other hour for a period of 2 successive 8-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- 3.9.3. Measure outside-air, wet- and dry-bulb temperatures.

3.10. **TEMPERATURE-CONTROL VERIFICATION:**

- 3.10.1. Verify that controllers are calibrated and commissioned.
- 3.10.2. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- 3.10.3. Record controller settings and note variances between set points and actual measurements.
- 3.10.4. Verify operation of limiting controllers (i.e., high- and low-temperature controllers).
- 3.10.5. Verify free travel and proper operation of control devices such as damper and valve operators.
- 3.10.6. Verify sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water-flow measurements. Note the speed of response to input changes.
- 3.10.7. Confirm interaction of electrically operated switch transducers.
- 3.10.8. Confirm interaction of interlock and lockout systems.
- 3.10.9. Verify main control supply-air pressure and observe compressor and dryer operations.

- 3.10.10. Record voltages of power supply and controller output. Determine if the system operates on a grounded or nongrounded power supply.
- 3.10.11. Note operation of electric actuators using spring return for proper fail-safe operations.
- 3.11. **TOLERANCES:**
  - 3.11.1. Set HVAC system airflow and water flow rates within the following tolerances:
    - 3.11.1.1. Supply, Return, and Exhaust Fans: Minus 5 to plus 10 percent.
    - 3.11.1.2. Air Outlets and Inlets: 0 to plus 10 percent.
- 3.12. **REPORTING:**
  - 3.12.1. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article above, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
  - 3.12.2. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.
- 3.13. **FINAL REPORT:**
  - 3.13.1. General: Typewritten, or computer printout in letter- quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.
  - 3.13.2. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
    - 3.13.2.1. Include a list of the instruments used for procedures, along with proof of calibration.
  - 3.13.3. Final Report Contents: In addition to the certified field report data, include the following:
    - 3.13.3.1. Fan curves.
    - 3.13.3.2. Manufacturers' test data.
    - 3.13.3.3. Field test reports prepared by system and equipment installers.
    - 3.13.3.4. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.

- 3.13.4. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:
  - 3.13.4.1. Title page.
  - 3.13.4.2. Name and address of testing, adjusting, and balancing Agent.
  - 3.13.4.3. Project name.
  - 3.13.4.4. Project location.
  - 3.13.4.5. Architect's name and address.
  - 3.13.4.6. Engineer's name and address.
  - 3.13.4.7. Contractor's name and address.
  - 3.13.4.8. Report date.
  - 3.13.4.9. Signature of testing, adjusting, and balancing Agent who certifies the report.
  - 3.13.4.10. Summary of contents, including the following:
    - 3.13.4.10.1. Design versus final performance.
    - 3.13.4.10.2. Notable characteristics of systems.
    - 3.13.4.10.3. Description of system operation sequence if it varies from the Contract Documents.
  - 3.13.4.11. Nomenclature sheets for each item of equipment.
  - 3.13.4.12. Data for terminal units, including manufacturer, type size, and fittings.
  - 3.13.4.13. Notes to explain why certain final data in the body of reports vary from design values.
  - 3.13.4.14. Test conditions for fans performance forms, including the following:
    - 3.13.4.14.1. Settings for outside-, return-, and exhaust-air dampers.
    - 3.13.4.14.2. Conditions of filters.
    - 3.13.4.14.3. Cooling coil, wet- and dry-bulb conditions.
    - 3.13.4.14.4. Fan drive settings, including settings and percentage of maximum pitch diameter.
    - 3.13.4.14.5. Settings for supply-air, static-pressure controller.
    - 3.13.4.14.6. Other system operating conditions that affect performance.

- 3.13.5. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present with single-line diagrams and include the following:
  - 3.13.5.1. Quantities of outside, supply, return, and exhaust airflows.
  - 3.13.5.2. Duct, outlet, and inlet sizes.
  - 3.13.5.3. Balancing stations.
- 3.13.6. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
  - 3.13.6.1. Unit Data: Include the following:
    - 3.13.6.1.1. Unit identification.
    - 3.13.6.1.2. Location.
    - 3.13.6.1.3. Make and type.
    - 3.13.6.1.4. Model number and unit size.
    - 3.13.6.1.5. Manufacturer's serial number.
    - 3.13.6.1.6. Unit arrangement and class.
    - 3.13.6.1.7. Discharge arrangement.
    - 3.13.6.1.8. Sheave make, size in inches (mm), and bore.
    - 3.13.6.1.9. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).
    - 3.13.6.1.10. Number of belts, make, and size.
    - 3.13.6.1.11. Number of filters, type, and size.
  - 3.13.6.2. Motor Data: Include the following:
    - 3.13.6.2.1. Make and frame type and size.
    - 3.13.6.2.2. Horsepower and rpm.
    - 3.13.6.2.3. Volts, phase, and hertz.
    - 3.13.6.2.4. Full-load amperage and service factor.
    - 3.13.6.2.5. Sheave make, size in inches (mm), and bore.
    - 3.13.6.2.6. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).
  - 3.13.6.3. Test Data: Include design and actual values for the following:

- 3.13.6.3.1. Total airflow rate in cfm (L/s).
- 3.13.6.3.2. Total system static pressure in inches wg (Pa).
- 3.13.6.3.3. Fan rpm.
- 3.13.6.3.4. Discharge static pressure in inches wg (Pa).
- 3.13.6.3.5. Filter static-pressure differential in inches wg (Pa).
- 3.13.6.3.6. Cooling coil static-pressure differential in inches wg (Pa).
- 3.13.6.3.7. Outside airflow in cfm (L/s).
- 3.13.6.3.8. Return airflow in cfm (L/s).
- 3.13.6.3.9. Outside-air damper position.
- 3.13.6.3.10. Return-air damper position.
- 3.13.6.3.11. Vortex damper position.
- 3.13.7. Fan Test Reports: For supply, return, and exhaust fans, include the following:
  - 3.13.7.1. Fan Data: Include the following:
    - 3.13.7.1.1. System identification.
    - 3.13.7.1.2. Location.
    - 3.13.7.1.3. Make and type.
    - 3.13.7.1.4. Model number and size.
    - 3.13.7.1.5. Manufacturer's serial number.
    - 3.13.7.1.6. Arrangement and class.
    - 3.13.7.1.7. Sheave make, size in inches (mm), and bore.
    - 3.13.7.1.8. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).
- 3.13.8. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
  - 3.13.8.1. Report Data: Include the following:
    - 3.13.8.1.1. System and air-handling unit number.
    - 3.13.8.1.2. Location and zone.
    - 3.13.8.1.3. Traverse air temperature in deg F (deg C).

- 3.13.8.1.4. Duct static pressure in inches wg (Pa).
- 3.13.8.1.5. Duct size in inches (mm).
- 3.13.8.1.6. Duct area in sq. ft. ( (sq. m)).
- 3.13.8.1.7. Design airflow rate in cfm (L/s).
- 3.13.8.1.8. Design velocity in fpm (m/s).
- 3.13.8.1.9. Actual airflow rate in cfm (L/s).
- 3.13.8.1.10. Actual average velocity in fpm (m/s).
- 3.13.8.1.11. Barometric pressure in psig (Pa).
- 3.13.9. Air-Terminal-Device Reports: For terminal units, include the following:
  - 3.13.9.1. Unit Data: Include the following:
    - 3.13.9.1.1. System and air-handling unit identification.
    - 3.13.9.1.2. Location and zone.
    - 3.13.9.1.3. Test apparatus used.
    - 3.13.9.1.4. Area served.
    - 3.13.9.1.5. Air-terminal-device make.
    - 3.13.9.1.6. Air-terminal-device number from system diagram.
    - 3.13.9.1.7. Air-terminal-device type and model number.
    - 3.13.9.1.8. Air-terminal-device size.
    - 3.13.9.1.9. Air-terminal-device effective area in sq. ft. ( (sq. m)).
  - 3.13.9.2. Test Data: Include design and actual values for the following:
    - 3.13.9.2.1. Airflow rate in cfm (L/s).
    - 3.13.9.2.2. Air velocity in fpm (m/s).
    - 3.13.9.2.3. Preliminary airflow rate as needed in cfm (L/s).
    - 3.13.9.2.4. Preliminary velocity as needed in fpm (m/s).
    - 3.13.9.2.5. Final airflow rate in cfm (L/s).
    - 3.13.9.2.6. Final velocity in fpm (m/s).
    - 3.13.9.2.7. Space temperature in deg F (deg C).

- 3.13.10. Instrument Calibration Reports: For instrument calibration, include the following:
  - 3.13.10.1. Report Data: Include the following:
    - 3.13.10.1.1. Instrument type and make.
    - 3.13.10.1.2. Serial number.
    - 3.13.10.1.3. Application.
    - 3.13.10.1.4. Dates of use.
    - 3.13.10.1.5. Dates of calibration.

## **SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS**

### **PART 1. GENERAL**

#### **1.1. RELATED DOCUMENTS:**

- 1.1.1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### **1.2. SUMMARY:**

- 1.2.1. This Section includes the following electrical materials and methods:
  - 1.2.1.1. Concrete equipment bases.
  - 1.2.1.2. Electrical identification.
  - 1.2.1.3. Electrical demolition.
  - 1.2.1.4. Cutting and patching for electrical construction.
  - 1.2.1.5. Touchup painting.
  - 1.2.1.6. Meter sockets.

#### **1.3. SUBMITTALS:**

- 1.3.1. Product Data for each type of product specified.

#### **1.4. QUALITY ASSURANCE:**

- 1.4.1. Comply with NFPA 70 for components and installation.
- 1.4.2. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
  - 1.4.2.1. The Terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.
  - 1.4.2.2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

#### **1.5. SEQUENCING AND SCHEDULING:**

- 1.5.1. Coordinate electrical equipment installation with other building components.
- 1.5.2. Arrange for chases, slots, and openings in building structure during progress of construction to allow for electrical installations.

- 1.5.3. Coordinate installing required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- 1.5.4. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning prior to closing in the building.
- 1.5.5. Coordinate connecting electrical service to components furnished under other Sections.
- 1.5.6. Coordinate connecting electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- 1.5.7. Coordinate requirements for access panels and doors where electrical items requiring access are concealed by finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors."
- 1.5.8. Coordinate installing electrical identification after completion of finishing where identification is applied to field-finished surfaces.
- 1.5.9. Coordinate installing electrical identifying devices and markings prior to installing acoustical ceilings and similar finishes that conceal such items.

## **PART 2. PRODUCTS**

- 2.1. **SUPPORTING DEVICES:**
  - 2.1.1. Channel and angle support systems, hangers, anchors, sleeves, brackets, fabricated items, and fasteners are designed to provide secure support from the building structure for electrical components.
    - 2.1.1.1. Material: Steel, except as otherwise indicated, protected from corrosion with zinc coating or with treatment of equivalent corrosion resistance using approved alternative finish or inherent material characteristics.
    - 2.1.1.2. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel, except as otherwise indicated.
  - 2.1.2. Steel channel supports have 9/16-inch (14-mm) diameter holes at a maximum of 8 inches (203 mm) o.c., in at least 1 surface.
    - 2.1.2.1. Fittings and accessories mate and match with channels and are from the same manufacturer.
  - 2.1.3. Nonmetallic Channel and Angle Systems: Structural-grade, factory-formed, fiberglass-resin channels and angles with 9/16-

inch (14-mm) diameter holes at a maximum of 8 inches (203 mm) o.c., in at least 1 surface.

- 2.1.3.1. Fittings and accessories mate and match with channels or angles and are from the same manufacturer.
- 2.1.3.2. Fitting and Accessory Material: Same as channels and angles, except metal items may be stainless steel.
- 2.1.4. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps or "click"- type hangers.
- 2.1.5. Sheet-Metal Sleeves: 0.0276-inch (0.7-mm) or heavier galvanized sheet steel, round tube, closed with welded longitudinal joint.
- 2.1.6. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- 2.1.7. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable iron casting with hot-dip galvanized finish.
- 2.1.8. Expansion Anchors: Carbon-steel wedge or sleeve type.
- 2.1.9. Toggle Bolts: All-steel springhead type.
- 2.1.10. Powder-Driven Threaded Studs: Heat-treated steel.

## 2.2. **CONCRETE EQUIPMENT BASES:**

- 2.2.1. Forms and Reinforcing Materials: As specified in Division 3 Section "Cast-in-Place Concrete."
- 2.2.2. Concrete: 3000-psi (20.7-MPa), 28-day compressive strength as specified in Division 3 Section "Cast-in-Place Concrete."

## 2.3. **ELECTRICAL IDENTIFICATION:**

- 2.3.1. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- 2.3.2. Raceway and Cable Labels: Conform to ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway or cable size.
  - 2.3.2.1. Type: Preprinted, flexible, self-adhesive, vinyl. Legend is overlaminated with a clear, weather- and chemical-resistant

coating.

- 2.3.2.2. Color: Black legend on orange field.
- 2.3.2.3. Legend: Indicates voltage.
- 2.3.3. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch wide (0.08 mm thick by 25 mm wide).
- 2.3.4. Underground Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape with the following features:
  - 2.3.4.1. Size: Not less than 4 mils thick by 6 inches wide (0.102 mm thick by 152 mm wide).
    - 2.3.4.1.1. Compounded for permanent direct-burial service.
    - 2.3.4.2. Embedded continuous metallic strip or core.
      - 2.3.4.2.1. Printed Legend: Indicates type of underground line.
  - 2.3.5. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
  - 2.3.6. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.
  - 2.3.7. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched for mechanical fasteners 1/16-inch (1.6-mm) minimum thick for signs up to 20 sq. in. (129 sq. cm), 1/8 inch (3.2 mm) thick for larger sizes. Engraved legend in black letters on white face.
  - 2.3.8. Interior Warning and Caution Signs: Preprinted, aluminum, baked-enamel finish signs, punched for fasteners, with colors, legend, and size appropriate to the application.
  - 2.3.9. Exterior Warning and Caution Signs: Weather-resistant, nonfading, preprinted, cellulose acetate butyrate signs with 0.0396-inch (1-mm), galvanized steel backing, with colors, legend, and size appropriate to the application. 1/4-inch (6.4-mm) grommets in corners for mounting.
  - 2.3.10. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.
- 2.4. **METER SOCKETS:**
  - 2.4.1. Meter sockets comply with serving utility company requirements.
- 2.5. **TOUCHUP PAINT:**
  - 2.5.1. For Equipment: Provided by equipment manufacturer and selected

to match equipment finish.

- 2.5.2. For Nonequipment Surfaces: Matching type and color of undamaged, existing adjacent finish.
- 2.5.3. For Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

### **PART 3. EXECUTION**

#### **3.1. EQUIPMENT INSTALLATION REQUIREMENTS:**

- 3.1.1. Install components and equipment to provide the maximum possible headroom where mounting heights or other location criteria are not indicated.
- 3.1.2. Install items level, plumb, and parallel and perpendicular to other building systems and components, except where otherwise indicated.
- 3.1.3. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- 3.1.4. Give right of way to raceways and piping systems installed at a required slope.

#### **3.2. ELECTRICAL SUPPORTING METHODS:**

- 3.2.1. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.
- 3.2.2. Dry Locations: Steel materials.
- 3.2.3. Support Clamps for PVC Raceways: Click-type clamp system.
- 3.2.4. Conform to manufacturer's recommendations for selecting supports.
- 3.2.5. Strength of Supports: Adequate to carry all present and future loads, times a safety factor of at least 4; 200-lb- (90-kg-) minimum design load.

#### **3.3. INSTALLATION:**

- 3.3.1. Install devices to securely and permanently fasten and support electrical components.
- 3.3.2. Raceway Supports: Comply with NFPA 70 and the following requirements:
  - 3.3.2.1. Conform to manufacturer's recommendations for selecting and installing supports.
  - 3.3.2.2. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U bolts, clamps, attachments, and

other hardware necessary for hanger assembly and for securing hanger rods and conduits.

- 3.3.2.3. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- 3.3.2.4. Spare Capacity: Size supports for multiple conduits so capacity can be increased by a 25 percent minimum in the future.
- 3.3.2.5. Support individual horizontal raceways with separate, malleable iron pipe hangers or clamps.
- 3.3.2.6. Hanger Rods: 1/4-inch (6-mm) diameter or larger threaded steel, except as otherwise indicated.
- 3.3.2.7. Spring Steel Fasteners: Specifically designed for supporting single conduits or tubing. May be used in lieu of malleable iron hangers for 1-1/2-inch (38-mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to channel and slotted angle supports.
- 3.3.2.8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports, with no weight load on raceway terminals.
- 3.3.3. Vertical Conductor Supports: Install simultaneously with conductors.
- 3.3.4. Miscellaneous Supports: Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices except where components are mounted directly to structural features of adequate strength.
- 3.3.5. In open overhead spaces, cast boxes threaded to raceways need not be separately supported, except where used for fixture support; support sheet-metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches (610 mm) from the box.
- 3.3.6. Sleeves: Install for cable and raceway penetrations of concrete slabs and walls, except where core-drilled holes are used. Install for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- 3.3.7. Firestopping: Apply to cable and raceway penetrations of fire-rated floor and wall assemblies. Perform firestopping as specified in Division 7 Section "Firestopping" to reestablish the original fire-resistance rating of the assembly at the penetration.

- 3.3.8. Fastening: Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure. Perform fastening according to the following:
  - 3.3.8.1. Fasten by means of wood screws or screw-type nails on wood; toggle bolts on hollow masonry units; concrete inserts or expansion bolts on concrete or solid masonry; and by machine screws, welded threaded studs, or spring- tension clamps on steel.
  - 3.3.8.2. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts, machine screws, or wood screws.
  - 3.3.8.3. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or any other items.
  - 3.3.8.4. In partitions of light steel construction use sheet- metal screws.
  - 3.3.8.5. Drill holes in concrete beams so holes more than 1-1/2 inches (38 mm) deep do not cut main reinforcing bars.
  - 3.3.8.6. Drill holes in concrete so holes more than 3/4 inch (19 mm) deep do not cut main reinforcing bars.
  - 3.3.8.7. Fill and seal holes drilled in concrete and not used.
  - 3.3.8.8. Select fasteners so the load applied to any fastener does not exceed 25 percent of the proof-test load.
- 3.3.9. Install concrete pads and bases according to requirements of Division 3 Section "Cast-in-Place Concrete."
- 3.3.10. Install utility-metering equipment according to utility company's written requirements. Provide grounding and empty conduits as required by company.
- 3.3.11. Install identification devices where required.
  - 3.3.11.1. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
  - 3.3.11.2. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated on the Contract Documents or required by codes and standards. Use consistent designations throughout the Project.
  - 3.3.11.3. Self-Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.
  - 3.3.11.4. Identify raceways and cables of certain systems with color

banding as follows:

- 3.3.11.4.1. Bands: Colored adhesive marking tape. Make each color band 2 inches (51 mm) wide, completely encircling conduit, and place adjacent bands of 2- color markings in contact, side by side.
- 3.3.11.4.2. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25 feet (8 m) in congested areas.
- 3.3.11.4.3. Colors: As follows:
  - 3.3.11.4.3.1. Fire-Alarm System: Red.
- 3.3.11.5. Tag or label power circuits for future connection and circuits in raceways and enclosures with other circuits. Identify source and circuit numbers in each cabinet, pull box, junction box, and outlet box. Color coding may be used for voltage and phase indication.
- 3.3.11.6. Identify Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above power and communication lines. Locate 6 to 8 inches (150 to 200 mm) below finished grade. Where multiple lines installed in a common trench or concrete envelope do not exceed an overall width of 16 inches (400 mm), use a single line marker.
- 3.3.11.7. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker. Update existing panel schedules.
- 3.4. **DEMOLITION:**
  - 3.4.1. Where electrical work to remain is damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
  - 3.4.2. Accessible Work Indicated to Be Demolished: Remove exposed electrical installation in its entirety.
  - 3.4.3. Abandoned Work: Cut and remove buried raceway and wiring indicated to be abandoned in place, 2 inches (50 mm) below the surface of adjacent construction. Cap and patch surface to match existing finish.
  - 3.4.4. Removal: Remove demolished material from the Project site.
  - 3.4.5. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.
- 3.5. **CUTTING AND PATCHING:**

- 3.5.1. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for electrical installations. Perform cutting by skilled mechanics of the trades involved.
- 3.5.2. Repair disturbed surfaces to match adjacent undisturbed surfaces.
- 3.6. **TOUCHUP PAINTING:**
- 3.6.1. Thoroughly clean damaged areas and provide primer, intermediate, and finish coats to suit the degree of damage at each location.
- 3.6.2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

## **SECTION 16120 - CONDUCTORS AND CABLES**

### **PART 1. GENERAL**

#### **1.1. RELATED DOCUMENTS:**

- 1.1.1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### **1.2. SUMMARY:**

- 1.2.1. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

#### **1.3. SUBMITTALS:**

- 1.3.1. Product data for each type of product specified.

#### **1.4. QUALITY ASSURANCE:**

- 1.4.1. Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled.
  - 1.4.1.1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
  - 1.4.1.2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- 1.4.2. Comply with NFPA 70.
- 1.5. **DELIVERY, STORAGE, AND HANDLING:**
  - 1.5.1. Deliver wires and cables according to NEMA WC 26.
- 1.6. **COORDINATION:**
  - 1.6.1. Coordinate layout and installation of cables with other installations.
  - 1.6.2. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by Architect.

### **PART 2. PRODUCTS**

#### **2.1. BUILDING WIRES AND CABLES:**

- 2.1.1. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in

Part 3 "Wire and Insulation Applications" Article.

- 2.1.2. Thermoplastic Insulation Material: Comply with NEMA WC 5.
- 2.1.3. Cross-Linked Polyethylene Insulation Material: Comply with NEMA WC 7.
- 2.1.4. Ethylene Propylene Rubber Insulation Material: Comply with NEMA WC 8.
- 2.1.5. Conductor Material: Copper.
- 2.1.6. Stranding: Solid conductor for No. 10 AWG and smaller; stranded conductor for larger than No. 10 AWG.
- 2.2. **CONNECTORS AND SPLICES:**
  - 2.2.1. UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated. Comply with Project's installation requirements and as specified in Part 3 "Wire and Insulation Applications" Article.

### **PART 3. EXECUTION**

- 3.1. **EXAMINATION:**
  - 3.1.1. Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.
- 3.2. **WIRE AND INSULATION APPLICATIONS:**
  - 3.2.1. Service Entrance: Type RHW or THWN, in raceway.
  - 3.2.2. Feeders: Type THHN/THWN, in raceway.
  - 3.2.3. Branch Circuits: Type THHN/THWN, in raceway.
  - 3.2.4. Fire Alarm Circuits: Type THHN/THWN, in raceway.
  - 3.2.5. Class 1 Control Circuits: Type THHN/THWN, in raceway.
  - 3.2.6. Class 2 Control Circuits: Type THHN/THWN, in raceway.
- 3.3. **INSTALLATION:**
  - 3.3.1. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's "Standard of Installation."
  - 3.3.2. Remove existing wires from raceway before pulling in new wires

and cables.

- 3.3.3. Pull Conductors: Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- 3.3.4. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- 3.3.5. Identify wires according to Division 16 Section "Basic Electrical Materials and Methods."
- 3.4. **CONNECTIONS:**
  - 3.4.1. Conductor Splices: Keep to minimum.
  - 3.4.2. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
  - 3.4.3. Use splice and tap connectors compatible with conductor material.
  - 3.4.4. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.
  - 3.4.5. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.
  - 3.4.6. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

## **SECTION 16124 - MEDIUM-VOLTAGE CABLES**

### **PART 1. GENERAL**

#### **1.1. RELATED DOCUMENTS:**

- 1.1.1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### **1.2. SUMMARY:**

- 1.2.1. This Section includes cables and related splices, terminations, and accessories for 15,000-volt electrical distribution systems.
- 1.2.2. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1.2.2.1. Division 16 Section "Supporting Devices" for cable and termination supports.
  - 1.2.2.2. Division 16 Section "Medium-Voltage Transformers" for cable termination provisions.
  - 1.2.2.3. Division 16 Section "Medium-Voltage Switchgear" for cable termination provisions.

#### **1.3. SUBMITTALS:**

- 1.3.1. Product data for cables and cable accessories, including splices and terminations.
- 1.3.2. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Architects and Owners, and other information specified.
- 1.3.3. Product Test Reports: Certified reports of manufacturers' design and production tests indicating compliance of cable and accessories with referenced standards.
- 1.3.4. Field test reports indicating and interpreting test results relative to compliance with performance requirements specified. Include certified copies of field test records.

#### **1.4. QUALITY ASSURANCE:**

- 1.4.1. Installer Qualifications: Engage an experienced and certified cable splicer to install, splice, and terminate medium-voltage cable.
- 1.4.2. Manufacturer Qualifications: Firm experienced in manufacturing medium-voltage cable and accessories similar to those indicated for this Project, with a record of successful in-service performance.
- 1.4.3. Testing Firm Qualifications: In addition to the requirements specified in Division 1 Section "Quality Control Services," an independent testing firm shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company of the International Electrical Testing Association (NETA).
- 1.4.3.1. Testing Firm's Field Supervisor Qualifications: A person currently certified by the NETA or National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- 1.4.4. Comply with NFPA 70 "National Electrical Code" for components and installation.
- 1.4.5. Comply with IEEE C2 "National Electrical Safety Code" for components and installation.
- 1.4.6. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
- 1.4.6.1. The Terms "Listed and Labeled": As defined in the "National Electrical Code," Article 100.
- 1.4.6.2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- 1.4.7. Single-Source Responsibility: All medium-voltage cable shall be the product of a single manufacturer.
- 1.5. **DELIVERY, STORAGE, AND HANDLING:**
- 1.5.1. Deliver medium-voltage cable on factory reels conforming to NEMA WC 26.
- 1.5.2. Store cables on reels on elevated platforms in a dry location.

## **PART 2. PRODUCTS**

### **2.1. CABLES:**

- 2.1.1.1. Type: MV90.
- 2.1.1.2. Conductor: Copper.
- 2.1.1.3. Conductor Stranding: Compactor or Class B.
- 2.1.1.4. Insulation: Ethylene-propylene rubber (EPR) conforming to AEIC CS6.
  - 2.1.1.4.1. Voltage Rating: 15 kV.
  - 2.1.1.4.2. Insulation Thickness: 133 percent insulation level.
- 2.1.1.5. Shielding: Copper tape, helically applied over semiconducting insulation shield.
- 2.1.1.6. Jacket: Sunlight-resistant PVC.
- 2.2. **SPLICE KITS:**
  - 2.2.1. Splicing Products: As recommended in writing by the splicing kit manufacturer for the specific sizes, ratings, and configurations of cable conductors and splices specified. Include all components required for complete splice, with detailed instructions.
    - 2.2.1.1. Premolded, cold-shrink rubber, inline splicing kit.
- 2.3. **SOLID TERMINATIONS:**
  - 2.3.1. Multiconductor Cable Sheath Seals: Type recommended by the seal manufacturer for the type of cable and installation conditions, including orientation.
    - 2.3.1.1. Cold-shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.
  - 2.3.2. Conductor Terminations: Comply with IEEE Standard 48, as indicated. Insulation class equivalent to that of the cable. Terminations for shielded cables include a shield grounding strap.
- 2.4. **SEPARABLE INSULATED CONNECTORS:**
  - 2.4.1. Separable Insulated Connectors: Modular system complying with IEEE 386. Disconnecting, single-pole, cable terminators and matching stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

- 2.4.1.1. Load-Break Cable Terminators: Elbow-type units with 200-ampere load make/break and continuous current rating. Coordinate with insulation diameter and conductor size and material of cable being terminated. Include capacitively coupled test point on terminator body.
- 2.4.1.2. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding 3 phases of feeders, and carrying case.
- 2.4.1.3. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable elbow terminator.
- 2.4.1.4. Test Point Fault Indicators: Arranged for installation in test points of load-break separable connectors. Self-resetting indicators capable of being installed with a shotgun hot stick and tested with a test tool. Current trip ratings as indicated.
- 2.5. **ARC-PROOFING MATERIALS:**
- 2.5.1. Tape for First Course on Metal Objects: 10-mil (250-micron) - thick, corrosion-protective, moisture-resistant PVC pipe-wrapping tape.
- 2.5.2. Arc-Proofing Tape: NRTL-listed fireproofing tape, flexible, conformable, intumescent to 0.3 inch (8 mm) thick, and compatible with the cable jacket on which used.
- 2.5.3. Glass Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch (13 mm) wide.
- 2.6. **SOURCE QUALITY CONTROL:**
- 2.6.1. Test and inspect cables according to NEMA WC 7 and NEMA WC 8 before shipping.

### **PART 3. EXECUTION**

- 3.1. **EXAMINATION:**
- 3.1.1. Examine raceways to receive medium-voltage cables for compliance with installation tolerances and other conditions affecting performance of the cable. Do not proceed with installation until unsatisfactory conditions have been corrected.
- 3.2. **INSTALLATION:**

- 3.2.1. Install medium-voltage cable as indicated, according to manufacturer's written instructions and IEEE 576.
- 3.2.2. Pull conductors simultaneously where more than one cable is indicated in same raceway. Use NRTL-listed and manufacturer-approved pulling compound or lubricant where necessary. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- 3.2.3. Use pulling means including, fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceways. Do not use rope hitches for pulling attachment to cable.
- 3.2.4. Install exposed cable parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- 3.2.5. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.
- 3.2.6. Install splices at pull points and elsewhere as indicated using standard kit. Conform to kit manufacturer's written instructions.
- 3.2.7. Install terminations at ends of conductors and seal multiconductor cable ends with standard kits. Conform to manufacturer's written instructions. Comply with classes of terminations indicated.
- 3.2.8. Install separable insulated connector components where indicated in accordance with manufacturer's written instructions.
- 3.2.9. Arc-Proofing: Arc-proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials except where indicated. Apply as follows and as recommended by the manufacturer of the arc-proofing tape.
  - 3.2.9.1. Clean cable sheath.
  - 3.2.9.2. Wrap metallic cable components with 10-mil (250-micron) pipe wrapping tape.
  - 3.2.9.3. Smooth surface contours with electrical insulation putty.
  - 3.2.9.4. Apply arc-proofing tape in one half-lapped layer with the coated side toward the cable.
  - 3.2.9.5. Band the arc-proofing tape with 1-inch (25mm) -wide bands of half-lapped adhesive glass-cloth tape 2 inches (50 mm) on center.

3.2.10. Fault Indicators: Install fault indicators on each phase where indicated.

3.3. **GROUNDING:**

3.3.1. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated connector fittings, and hardware according to manufacturer's written instructions.

3.4. **IDENTIFICATION:**

3.4.1. Identify cable in accordance with Division 16 Section "Electrical Identification."

3.5. **FIELD QUALITY CONTROL:**

3.5.1. Testing Firm: Owner will employ and pay an independent testing firm to perform specified field quality-control testing.

3.5.2. Testing Firm: Provide the services of a qualified independent testing firm to perform specified field quality- control testing.

3.5.3. Testing: Upon installation of medium-voltage cable and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

3.5.3.1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA Standard ATS, Section 7.3.2. Certify compliance with test parameters.

3.5.4. Correct malfunctioning units at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

## **SECTION 16130 - RACEWAYS AND BOXES**

### **PART 1. GENERAL**

#### **1.1. RELATED DOCUMENTS:**

- 1.1.1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### **1.2. SUMMARY:**

- 1.2.1. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

- 1.2.1.1. Raceways include the following:

- 1.2.1.1.1. RMC.

- 1.2.1.1.2. IMC.

- 1.2.1.1.3. PVC externally coated, rigid steel conduits.

- 1.2.1.1.4. PVC externally coated, IMC.

- 1.2.1.1.5. EMT.

- 1.2.1.1.6. FMC.

- 1.2.1.1.7. LFMC.

- 1.2.1.1.8. RNC.

- 1.2.1.1.9. Wireways.

- 1.2.1.1.10. Surface raceways.

- 1.2.1.2. Boxes, enclosures, and cabinets include the following:

- 1.2.1.2.1. Device boxes.

- 1.2.1.2.2. Outlet boxes.

- 1.2.1.2.3. Pull and junction boxes.

- 1.2.1.2.4. Cabinets and hinged-cover enclosures.

- 1.2.2. Related Sections include the following:

- 1.2.2.1. Division 16 Section "Basic Electrical Materials and Methods" for raceways and box supports.

1.3. **DEFINITIONS:**

- 1.3.1. EMT: Electrical metallic tubing.
- 1.3.2. FMC: Flexible metal conduit.
- 1.3.3. IMC: Intermediate metal conduit.
- 1.3.4. LFMC: Liquidtight flexible metal conduit.
- 1.3.5. RMC: Rigid metal conduit.
- 1.3.6. RNC: Rigid nonmetallic conduit.

1.4. **SUBMITTALS:**

- 1.4.1. Product Data: For surface raceways, wireways and fittings, hinged-cover enclosures, and cabinets.

1.5. **QUALITY ASSURANCE:**

- 1.5.1. Listing and Labeling: Provide raceways and boxes specified in this Section that are listed and labeled.
  - 1.5.1.1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
  - 1.5.1.2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- 1.5.2. Comply with NECA's "Standard of Installation."
- 1.5.3. Comply with NFPA 70.

1.6. **COORDINATION:**

- 1.6.1. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

**PART 2. PRODUCTS**

2.1. **METAL CONDUIT AND TUBING:**

- 2.1.1. Rigid Steel Conduit: ANSI C80.1.
- 2.1.2. Rigid Aluminum Conduit: ANSI C80.5.
- 2.1.3. IMC: ANSI C80.6.
- 2.1.4. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.

- 2.1.5. Plastic-Coated IMC and Fittings: NEMA RN 1.
- 2.1.6. EMT and Fittings: ANSI C80.3.
  - 2.1.6.1. Fittings: Set-screw or compression type.
- 2.1.7. FMC: Zinc-coated steel or aluminum.
- 2.1.8. LFMC: Flexible steel conduit with PVC jacket.
- 2.1.9. Fittings: NEMA FB 1; compatible with conduit/tubing materials.
- 2.2. **NONMETALLIC CONDUIT AND TUBING:**
  - 2.2.1. RNC: NEMA TC 2, Schedule 40 or 80 PVC.
  - 2.2.2. RNC Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.
- 2.3. **METAL WIREWAYS:**
  - 2.3.1. Material: Sheet metal sized and shaped as indicated.
  - 2.3.2. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
  - 2.3.3. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
  - 2.3.4. Wireway Covers: Hinged type.
  - 2.3.5. Finish: Manufacturer's standard enamel finish.
- 2.4. **SURFACE RACEWAYS:**
  - 2.4.1. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.
  - 2.4.2. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.
- 2.5. **OUTLET AND DEVICE BOXES:**
  - 2.5.1. Sheet Metal Boxes: NEMA OS 1.
  - 2.5.2. Cast-Metal Boxes: NEMA FB 1, Type FD, cast box with gasketed cover.
- 2.6. **PULL AND JUNCTION BOXES:**
  - 2.6.1. Small Sheet Metal Boxes: NEMA OS 1.

2.6.2. Cast-Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover.

2.7. **ENCLOSURES AND CABINETS:**

2.7.1. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.

2.7.1.1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2.7.2. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

**PART 3. EXECUTION**

3.1. **EXAMINATION:**

3.1.1. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2. **WIRING METHODS:**

3.2.1. Outdoors: Use the following wiring methods:

3.2.1.1. Exposed: Rigid steel or IMC.

3.2.1.2. Concealed: Rigid steel or IMC.

3.2.1.3. Underground, Single Run: RNC.

3.2.1.4. Underground, Grouped: RNC.

3.2.1.5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

3.2.1.6. Boxes and Enclosures: NEMA 250, Type 3R or Type 4.

3.2.2. Indoors: Use the following wiring methods:

3.2.2.1. Exposed: EMT or RNC.

3.2.2.2. Concealed: EMT, or RNC.

3.2.2.3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except in wet or damp locations, use LFMC.

- 3.2.2.4. Damp or Wet Locations: Rigid steel conduit.
- 3.2.2.5. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
  - 3.2.2.5.1. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.
- 3.3. **INSTALLATION:**
  - 3.3.1. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.
  - 3.3.2. Minimum Raceway Size: 3/4-inch trade size (DN21).
  - 3.3.3. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors.
  - 3.3.4. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
  - 3.3.5. Install raceways level and square and at proper elevations. Provide adequate headroom.
  - 3.3.6. Complete raceway installation before starting conductor installation.
  - 3.3.7. Support raceways as specified in Division 16 Section "Basic Electrical Materials and Methods."
  - 3.3.8. Use temporary closures to prevent foreign matter from entering raceways.
  - 3.3.9. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
  - 3.3.10. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
  - 3.3.11. Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.
  - 3.3.12. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.
  - 3.3.13. Raceways Embedded in Slabs: Install in middle third of slab thickness where practical, and leave at least 1-inch (25-mm) concrete cover.
    - 3.3.13.1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.

- 3.3.13.2. Space raceways laterally to prevent voids in concrete.
- 3.3.13.3. Run conduit larger than 1-inch trade size (DN27) parallel to or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
- 3.3.13.4. Transition from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above floor.
- 3.3.14. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.
  - 3.3.14.1. Run parallel or banked raceways together, on common supports where practical.
  - 3.3.14.2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- 3.3.15. Join raceways with fittings designed and approved for the purpose and make joints tight.
  - 3.3.15.1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
  - 3.3.15.2. Use insulating bushings to protect conductors.
- 3.3.16. Tighten set screws of threadless fittings with suitable tools.
- 3.3.17. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box.
- 3.3.18. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.
- 3.3.19. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of the pull wire.
- 3.3.20. Install raceway sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL- listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar

to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

- 3.3.20.1. Where conduits pass from warm to cold locations, such as the boundaries of refrigerated spaces.
- 3.3.20.2. Where otherwise required by NFPA 70.
- 3.3.21. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections.
- 3.3.22. Flexible Connections: Use maximum of 6 feet (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.
- 3.3.23. Do not install aluminum conduits embedded in or in contact with concrete.
- 3.3.24. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.
- 3.3.25. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying the raceways to receptacle or fixture ground terminals.
- 3.3.26. Install hinged-cover enclosures and cabinets plumb. Support at each corner.
- 3.4. **PROTECTION:**
- 3.4.1. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.
- 3.4.1.1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
- 3.4.1.2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.
- 3.5. **CLEANING:**
- 3.5.1. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips,

scratches, and abrasions.

## **SECTION 16320 - MEDIUM-VOLTAGE TRANSFORMERS**

### **PART 1. GENERAL**

#### **1.1. SUMMARY:**

1.1.1. This Section includes distribution and power transformers with medium-voltage primaries. Types of transformers specified in this Section include the following:

1.1.1.1. Liquid-filled, pad-mounted.

1.1.2. Related Sections: The following Section contains requirements that relate to this Section:

1.1.2.1. Division 16 Section "Secondary Unit Substations" for transformers integral to substations.

#### **1.2. DEFINITIONS:**

1.2.1. Listed: As defined in the "1999 National Electrical Code," Article 100.

1.2.2. Nationally Recognized Testing Laboratory (NRTL): A testing agency qualified as defined in OSHA Regulation 1910.7.

#### **1.3. SUBMITTALS:**

1.3.1. Product data for each product specified, including dimensioned plans, sections, and elevations. Show minimum clearances and installed devices and features.

#### **1.4. QUALITY ASSURANCE:**

1.4.1. Installer Qualifications: Engage an experienced Installer of medium-voltage electrical distribution equipment to perform the installation specified in this Section. Refer to Division 1 Section "Reference Standards and Definitions" for definition of an experienced Installer.

1.4.2. Field Testing Agency Qualifications: To qualify for acceptance, the testing agency must demonstrate, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated.

1.4.3. Comply with NFPA 70 "National Electrical Code."

1.4.4. Comply with IEEE C2 "National Electrical Safety Code."

#### **1.5. DELIVERY, STORAGE, AND HANDLING:**

1.5.1. Temporary Heating: Apply temporary heat according to manufacturer's recommendations within enclosure of each indoor

ventilated dry-type transformer throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

## **PART 2. PRODUCTS**

### **2.1. MANUFACTURERS:**

2.1.1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

2.1.1.1. General Electric Co.

2.1.1.2. Siemens Energy & Automation, Inc.

2.1.1.3. Square D Co.

2.1.1.4. Westinghouse.

### **2.2. TRANSFORMERS, GENERAL:**

2.2.1. Windings: Two-winding type, designed for operation with high-voltage windings connected to a 3-phase, 3-wire, 60-Hz, grounded neutral distribution system.

2.2.2. Low-Sound Level Transformers: Units with a sound level rating a minimum of 3 dB less than NEMA TR 1 standard sound levels for the transformer type and rating.

2.2.3. Unusual Service Conditions: Provide transformers designed for the following conditions:

2.2.3.1. Top-Liquid Temperature Sensing on Liquid-Filled Transformers: Thermally operated control device with thermal element mounted in a well, and provisions for mounting the control cabinet, the conduit, and the fans.

2.2.3.2. Winding Temperature Sensing on Liquid-Filled Transformers: Thermally operated winding temperature- control device with thermal element mounted in a well, a heating coil, and provisions for mounting the control cabinet, conduit, and fans.

2.2.4. Windings: Copper.

### **2.3. LIQUID-FILLED PAD-MOUNTED TRANSFORMERS:**

2.3.1. Comply with IEEE C57.12.22 and C57.12.28 and with the following features and ratings.

2.3.2. Insulating Liquid: Mineral oil, conforming to ASTM D 3487 "Specifications for Mineral Insulating Oil Used in Electrical Apparatus." Type II tested according to ASTM D 117 "Guide to Test Methods and Specifications for Electrical Insulating Oils of

Petroleum Origin."

- 2.3.3. Insulation Temperature Rise: 150 deg C.
- 2.3.4. Basic Impulse Insulation Level: 95 kV.
- 2.3.5. Full-Capacity Voltage Taps: Four nominal 2.5-percent taps, 2 above and 2 below rated high voltage, with externally operable tap changer for deenergized use, with position indicator.
- 2.3.6. High-Voltage Switching: Arranged for radial feed with 3- phase, 2-position, gang-operated, load-break switch, oil- immersed in transformer tank, with hook-stick-operated handle in the primary compartment.
- 2.3.7. Primary Fuse: Current limiting type in dry-fuse holder wells, mechanically interlocked with liquid immersed switch in transformer tank to prevent disconnect under load.
- 2.3.8. Surge Arresters: Distribution class, one for each primary phase. Comply with NEMA Standard LA 1 "Surge Arresters." Support from tank wall within high-voltage compartment.
- 2.3.9. High-Voltage Terminations and Equipment: Dead-front with universal-type bushing wells for dead-front bushing well inserts. Include the following:
  - 2.3.9.1. Bushing Well Inserts: One for each high-voltage bushing well.
  - 2.3.9.2. Lightning Arrestors: Dead-front elbow-type MOV units.
  - 2.3.9.3. Parking Stands: One for each high-voltage bushing well.
  - 2.3.9.4. Portable Insulated Bushings: Arranged for parking elbow terminators. One for each primary feeder conductor terminating at transformer.
- 2.3.10. Accessories: Provide the following accessories:
  - 2.3.10.1. One-inch (25-mm) drain valve with sampling device.
  - 2.3.10.2. Dial-type thermometer.
  - 2.3.10.3. Liquid level gage.
  - 2.3.10.4. Pressure-vacuum gage.
  - 2.3.10.5. Pressure-Relief Device: Self-sealing with indicator.
  - 2.3.10.6. Mounting provision for low-voltage current transformers and potential transformers.
  - 2.3.10.7. Watt hour meter with demand register.

2.4. **FINISHES:**

- 2.4.1. Enclosure Coating System for Outdoor Units: Comply with IEEE Standard C57.12.28 "Pad-Mounted Equipment-Enclosure Integrity," regardless of transformer type.
- 2.4.2. Color shall match existing pad mounted transformer throughout the site.

**PART 3. EXECUTION**

- 3.1. **FIELD QUALITY CONTROL:**
  - 3.1.1. Report: Submit a written report of observations and tests. Report defective materials and workmanship.
    - 3.1.1.1. Inspect accessible components for cleanliness, mechanical, and electrical integrity, for presence of damage or deterioration, and to ensure removal of temporary shipping bracing. Do not proceed with tests until deficiencies are corrected.
    - 3.1.1.2. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, where not available, those of UL Standards 486A and 486B.

## **SECTION 16341 - MEDIUM VOLTAGE PAD MOUNTED SWITCHGEAR**

### **PART 1. GENERAL**

#### **1.1 REFERENCES:**

- 1.1 ANSI C37.20.2 - Metal-Clad and Station-Type Cubicle Switchgear.
- 1.1.1 ANSI C37.20.3 - Metal-Enclosed Interrupter Switchgear.
- 1.1.2 ANSI C57.12.28 - Switchgear and Transformers--Pad-Mounted Equipment--Enclosure Integrity.
- 1.1.3 ANSI C57.13 - Requirements for Instrument Transformers.
- 1.1.4 IEEE 24 - Performance Characteristics and Dimensions for Outdoor Apparatus Bushings.
- 1.1.5 IEEE 48 - Test Procedures and Requirements for High-Voltage AC Cable Terminations.
- 1.1.6 NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- 1.1.7 NEMA 260 - Safety Labels for Padmounted Switchgear and Transformers Sited in Public Areas.
- 1.1.8 NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (International Electrical Testing Association).
- 1.1.9 NFPA 70 - National Electrical Code.

#### **1.2 SUBMITTALS FOR REVIEW:**

- 1.2.1 Product Data: Provide electrical characteristics and connection requirements, standard model design tests, and options.

#### **1.3 REGULATORY REQUIREMENTS:**

- 1.3.1 Conform to requirements of NFPA 70 and the National Electrical Safety Code.

#### **1.4 DELIVERY, STORAGE, AND HANDLING:**

1.4.1 Material and Equipment: Transport, handle, store, and protect products.

1.4.2 Accept pad mounted switchgear on site. Inspect for damage.

1.4.3 Protect products from weather and moisture by covering with heavy plastic or canvas and by maintaining heating within enclosure in accordance with manufacturer's instructions.

1.4.4 Protect switchgear from moisture by using appropriate heaters as instructed by the manufacturer.

1.5 **FIELD MEASUREMENTS:**

1.5.1 Verify that field measurements are as indicated on shop drawings.

1.6 **MAINTENANCE MATERIALS:**

1.6.1 Furnish two each of any special tools required to operate and maintain switchgear.

1.7 **EXTRA PRODUCTS:**

1.7.1 Furnish two of each size and type fuse.

1.8 **GENERAL**

1.8.1 The pad-mounted gear shall be in accordance with the one-line diagram, and shall conform to the following specification.

1.8.2 The pad-mounted gear shall consist of a single self-supporting enclosure, containing interrupter switches and power fuses with the necessary accessory components, all completely factory-assembled and operationally checked.

1.9 **Ratings**

1.9.1 The ratings for the integrated pad-mounted gear shall be as designated below.

Kv, Nominal ..... 13.8

Kv, Maximum ..... 17.0

Kv, BIL ..... 95

Main Bus Continuous, Amperes .... 600

Two-Time Duty-Cycle Fault-Closing,  
Amperes Rms Asymmetrical .. 40,000  
Short-Circuit Ratings  
Amperes Rms Symmetrical ..... 25,000  
Mva Three-Phase Symmetrical  
at Rated Nominal Voltage ..... 600

- 1.9.2 The momentary and two-time duty-cycle fault-closing ratings of switches, momentary rating of bus, interrupting ratings of fuses, and one-time duty-cycle fault-closing capabilities of fuses with integral load interrupters shall equal or exceed the short-circuit ratings of the pad-mounted gear.

1.10 **Certification of Ratings**

- 1.10.1 The manufacturer of the pad-mounted gear shall be completely and solely responsible for the performance of the basic switch and fuse components as well as the complete integrated assembly as rated.

- 1.10.2 The manufacturer shall furnish, upon request, certification of ratings of the basic switch and fuse components and/or the integrated pad-mounted gear assembly consisting of the switch and fuse components in combination with the enclosure.

1.11 **Compliance with Standards and Codes**

- 1.11.1 The pad-mounted gear shall conform to or exceed the applicable requirements of the following standards and codes:

- 1.11.1.1 All portions of ANSI C57.12.28, covering enclosure integrity for pad-mounted equipment.

- 1.11.1.2 Article 710-21(e) in the National Electrical Code, which specifies that the interrupter switches in combination with power fuses shall safely withstand the effects of closing, carrying, and interrupting all possible currents up to the assigned maximum short-circuit rating.

- 1.11.1.3 All portions of ANSI, IEEE, and NEMA standards applicable to the basic switch and fuse components.

## 1.12 Enclosure Design

- 1.12.1 To ensure a completely coordinated design, the pad-mounted gear shall be constructed in accordance with the minimum construction specifications of the fuse and/or switch manufacturer to provide adequate electrical clearances and adequate space for fuse handling.
- 1.12.2 In establishing the requirements for the enclosure design, consideration shall be given to all relevant factors such as controlled access, tamper resistance, and corrosion resistance.

## PART 2. PRODUCTS

### 2.1 Insulators

The interrupter-switch and fuse-mounting insulators shall be of a cycloaliphatic epoxy resin system with characteristics and restrictions as follows:

- 2.1.1 Operating experience of at least 15 years under similar conditions.
- 2.1.2 Adequate leakage distance established by test per IEC Publication 507, First Edition, 1975.
- 2.1.3 Adequate strength for short-circuit stress established by test.
- 2.1.4 Conformance with applicable ANSI standards.
- 2.1.5 Homogeneity of the cycloaliphatic epoxy resin throughout each insulator to provide maximum resistance to power arcs. Ablation due to high temperatures from power arcs shall continuously expose more material of the same composition and properties so that no change in mechanical or electrical characteristics takes place because of arc-induced ablation. Furthermore, any surface damage to insulators during installation or maintenance of the pad-mounted gear shall expose material of the same composition and properties so that insulators with minor surface damage need not be replaced.

## 2.2 **High-Voltage Bus**

- 2.2.1 Bus and interconnections shall consist of aluminum bar of 56% IACS conductivity.
- 2.2.2 Bus and interconnections shall withstand the stresses associated with short-circuit currents up through the maximum rating of the pad-mounted gear.
- 2.2.3 Bolted aluminum-to-aluminum connections shall be made with a suitable number of 1/2"-13 galvanized steel bolts and with two Belleville spring washers per bolt, one under the bolt head and one under the nut. Bolts shall be tightened to 50 foot-pounds torque.
- 2.2.4 Before installation of the bus, all electrical contact surfaces shall first be prepared by machine abrading to remove any aluminum-oxide film. Immediately after this operation, the electrical contact surfaces shall be coated with a uniform coating of an oxide inhibitor and sealant.

## 2.3 **Ground-Connection Pads**

- 2.3.1 A ground-connection pad shall be provided in each compartment of the pad-mounted gear.
- 2.3.2 The ground-connection pad shall be constructed of 3/8" thick steel, which shall be nickel plated and welded to the enclosure, and shall have a short-circuit rating equal to that of the pad-mounted gear.
- 2.3.3 Ground-connection pads shall be coated with a uniform coating of an oxide inhibitor and sealant prior to shipment.

## 2.4 **Enclosure**

- 2.4.1 The pad-mounted gear enclosure shall be of unitized monocoque (not structural-frame-and-bolted-sheet) construction to maximize strength, minimize weight, and inhibit corrosion.
- 2.4.2 The basic material shall be 11-gauge hot-rolled, pickled and oiled steel sheet.
- 2.4.3 All structural joints and butt joints shall be welded, and the external seams shall be ground flush and

smooth. The gas-metal-arc welding process shall be employed to eliminate alkaline residues and to minimize distortion and spatter.

- 2.4.4 To guard against unauthorized or inadvertent entry, enclosure construction shall not utilize any externally accessible hardware.
- 2.4.5 The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad.
- 2.4.6 The door openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between doors and door openings to guard against water entry.
- 2.4.7 Enclosure top side edges shall overlap with roof side edges to create a mechanical maze which shall allow ventilation to help keep the enclosure interior dry while discouraging tampering or insertion of foreign objects.
- 2.4.8 A heavy coat of insulating "no-drip" compound shall be applied to the inside surface of the roof to minimize condensation of moisture thereon.
- 2.4.9 Insulating interphase and end barriers of NEMA GPO3-grade fiberglass-reinforced polyester shall be provided for each interrupter switch and each set of fuses where required to achieve BIL ratings. Additional insulating barriers of the same material shall separate the front compartments from the rear compartments and isolate the tie bus (where furnished).
- 2.4.10 Full-length steel barriers shall separate side-by-side compartments.
- 2.4.11 Lifting tabs shall be removable. Sockets for the lifting-tab bolts shall be blind-tapped. A resilient material shall be placed between the lifting tabs and the enclosure to help prevent corrosion by protecting the finish against scratching by the tabs. To further preclude corrosion, this material shall be closed-cell to prevent moisture from being absorbed and held between the tabs and the enclosure in the event that lifting tabs are not removed.

- 2.4.12 Interrupter switches shall be provided with dual-purpose front barriers. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them into the open gap when the switch is open. A window panel shall be provided to allow viewing of the switch position without removing the barriers. These barriers shall meet the requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2).
- 2.4.13 Each fuse shall be provided with a dual-purpose front barrier. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them into the open gaps when the fuses are in the disconnect position. These barriers shall meet the requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2).
- 2.4.14 Inner barrier panels that meet the Rural Electrification Association's requirements for "dead-front" and the requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2) shall be provided—one for each door opening providing access to high voltage. These panels shall be secured in place with recessed pentahead bolts. When so secured, they shall guard against inadvertent contact with live parts.
- 2.5 **Doors**
- 2.5.1 Doors shall be constructed of 11-gauge hot-rolled, pickled and oiled steel sheet.
- 2.5.2 Door-edge flanges shall overlap with door-opening flanges and shall be formed to create a mechanical maze that shall guard against water entry and discourage tampering or insertion of foreign objects, but shall allow ventilation to help keep the enclosure interior dry.
- 2.5.3 Doors shall have a minimum of two extruded-aluminum hinges with stainless-steel hinge pins, and interlocking extruded-aluminum hinge supports for the full length of the door to provide strength, security, and corrosion resistance. Mounting hardware shall be stainless steel or zinc-nickel-plated steel, and shall

not be externally accessible to guard against tampering.

2.5.4 In consideration of controlled access and tamper resistance, each door (or set of double doors) shall be equipped with an automatic three-point latching mechanism.

2.5.4.1 The latching mechanism shall be spring loaded, and shall latch automatically when the door is closed. All latch points shall latch at the same time to preclude partial latching.

2.5.4.2 A pentahead socket wrench or tool shall be required to actuate the mechanism to unlatch the door and, in the same motion, recharge the spring for the next closing operation.

2.5.4.3 The latching mechanism shall have provisions for padlocking that incorporate a means to protect the padlock shackle from tampering and that shall be coordinated with the latches such that:

2.5.4.3.1 It shall not be possible to unlatch the mechanism until the padlock is removed, and

2.5.4.3.2 It shall not be possible to insert the padlock until the mechanism is completely latched closed.

2.5.5 Doors providing access to solid-material power fuses shall have provisions to store spare fuse units or refill units.

2.5.6 Each door shall be provided with a zinc-nickel-plated steel door holder located above the door opening. The holder shall be hidden from view when the door is closed, and it shall not be possible for the holder to swing inside the enclosure.

## 2.6 **Finish**

2.6.1 Full coverage at joints and blind areas shall be achieved by processing enclosures independently of components such as doors and roofs before assembly into the unitized structures.

2.6.2 All exterior seams shall be filled and sanded smooth for neat appearance.

- 2.6.3 To remove oils and dirt, to form a chemically and anodically neutral conversion coating to improve the finish-to-metal bond, and to retard underfilm propagation of corrosion, all surfaces shall undergo a thorough pretreatment process comprised of a fully automated system of cleaning, rinsing, phosphatizing, sealing, drying, and cooling before any protective coatings are applied. By utilizing an automated pretreatment process, the enclosure shall receive a highly consistent thorough treatment, eliminating fluctuations in reaction time, reaction temperature, and chemical concentrations.
- 2.6.4 After pretreatment, protective coatings shall be applied that shall help resist corrosion and protect the steel enclosure. To establish the capability to resist corrosion and protect the enclosure, representative test specimens coated by the enclosure manufacturer's finishing system shall satisfactorily pass the following tests:
  - 2.6.4.1 4000 hours of exposure to salt-spray testing per ASTM B 117 with:
    - 2.6.4.1.1 Underfilm corrosion not to extend more than 1/32" from the scribe as evaluated per ASTM D 1645, Procedure A, Method 2 (scraping); and
    - 2.6.4.1.2 Loss of adhesion from bare metal not to extend more than 1/8" from the scribe.
  - 2.6.4.2 1000 hours of humidity testing per ASTM D 4585 with no blistering as evaluated per ASTM D 714.
  - 2.6.4.3 500 hours of accelerated weathering testing per ASTM G 53 using lamp UVB-313 with no chalking as evaluated per ASTM D 659, and no more than 10% reduction of gloss as evaluated per ASTM D 523.
  - 2.6.4.4 Crosshatch adhesion testing per ASTM D 3359 Method B with no loss of finish.
  - 2.6.4.5 160-inch-pound impact adhesion testing per ASTM D 2794 with no chipping or cracking.
  - 2.6.4.6 Oil resistance testing consisting of a 72-hour immersion bath in mineral oil with no shift in color, no streaking, no blistering, and no loss of hardness.

- 2.6.4.7 3000 cycles of abrasion testing per ASTM 4060 with no penetration to the substrate.
- 2.6.5 After the finishing system has been properly applied and cured, welds along the enclosure bottom flange shall be coated with a wax-based anticorrosion moisture barrier to give these areas added corrosion resistance.
- 2.6.6 A resilient closed-cell material, such as PVC gasket, shall be applied to the entire underside of the enclosure bottom flange to protect the finish on this surface from scratching during handling and installation. This material shall isolate the bottom flange from the alkalinity of a concrete foundation to help protect against corrosive attack.
- 2.6.7 After the enclosure is completely assembled and the components (switches, fuses, bus, etc.) are installed, the finish shall be inspected for scuffs and scratches. Blemishes shall be touched up by hand to restore the protective integrity of the finish.
- 2.6.8 The finish shall be olive green, Munsell 7GY3.29/1.5.
- 2.7 To guard against corrosion, all hardware (including door fittings, fasteners, etc.), all operating-mechanism parts, and other parts subject to abrasive action from mechanical motion shall be of either nonferrous materials, or galvanized or zinc-nickel-plated ferrous materials. Cadmium-plated ferrous parts shall not be used.
- 2.8 **Interrupter Switches**
- 2.8.1 Interrupter switches shall have a two-time duty-cycle fault-closing rating equal to or exceeding the short-circuit rating of the pad-mounted gear. These ratings define the ability to close the interrupter switch twice against a three-phase fault with asymmetrical current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be performed at maximum voltage with current applied for at least 10 cycles. Certified test abstracts establishing such ratings shall be furnished upon request.
- 2.8.2 Interrupter switches shall be operated by means of an externally accessible 3/4" hex switch-operating hub.

The switch-operating hub shall be located within a recessed stainless-steel pocket mounted on the side of the pad-mounted gear enclosure and shall accommodate a 3/4" deep-socket wrench or a 3/4" shallow-socket wrench with extension. The switch-operating-hub pocket shall include a padlockable stainless-steel access cover that shall incorporate a hood to protect the padlock shackle from tampering. Stops shall be provided on the switch-operating hub to prevent overtravel and thereby guard against damage to the interrupter switch quick-make quick-break mechanism. Labels to indicate switch position shall be provided in the switch-operating-hub pocket.

- 2.8.3 Each interrupter switch shall be provided with a folding switch-operating handle. The switch-operating handle shall be secured to the inside of the switch-operating-hub pocket by a brass chain. The folded handle shall be stored behind the closed switch-operating-hub access cover.
- 2.8.4 Interrupter switches shall utilize a quick-make quick-break mechanism installed by the switch manufacturer. The quick-make quick-break mechanism shall be integrally mounted on the switch frame, and shall swiftly and positively open and close the interrupter switch independent of the switch-operating-hub speed.
- 2.8.5 Each interrupter switch shall be completely assembled and adjusted by the switch manufacturer on a single rigid mounting frame. The frame shall be of welded steel construction such that the frame intercepts the leakage path which parallels the open gap of the interrupter switch to positively isolate the load circuit when the interrupter switch is in the open position.
- 2.8.6 Interrupter switch contacts shall be backed up by stainless-steel springs to provide constant high contact pressure.
- 2.8.7 Interrupter switches shall be provided with a single blade per phase for circuit closing including fault closing, continuous current carrying, and circuit interrupting. Spring-loaded auxiliary blades shall not be permitted. Interrupter switch blade supports shall be permanently molded in place in a unified insulated shaft constructed of the same cycloaliphatic epoxy resin as the insulators.

- 2.8.8 Circuit interruption shall be accomplished by use of an interrupter which is positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence. Circuit interruption shall take place completely within the interrupter, with no external arc or flame. Any exhaust shall be vented in a controlled manner through a deionizing vent.
- 2.8.9 Interrupter switches shall have a readily visible open gap when in the open position to allow positive verification of switch position.
- 2.8.10 Key interlocks shall be provided to prevent paralleling the two source interrupter switches.
- 2.8.11 Base-mounted distribution-class surge arresters, metal-oxide type rated 9 kv, shall be provided at all source switch terminals.
- 2.8.12 Ground studs shall be provided at all switch terminals. Ground studs shall also be provided on the ground pad in each interrupter switch compartment and on terminals and ground pad in any bus compartment. The momentary rating of the ground studs shall equal or exceed the short-circuit ratings of the pad-mounted gear.
- 2.8.13 Cable guides shall be provided to help orient cables at switch terminals and bus-compartment terminals.

## 2.9 **Fuses**

- 2.9.1 Solid-Material Power Fuses
  - 2.9.1.1 Fuses shall be disconnect style, solid-material power fuses, and shall utilize refill-unit-and-holder or fuse-unit-and-end-fitting construction. The refill unit or fuse unit shall be readily replaceable and low in cost.
  - 2.9.1.2 Fusible elements shall be nonaging and nondamageable so that it is unnecessary to replace unblown companion fuses on suspicion of damage following a fuse operation.
  - 2.9.1.3 Fusible elements for refill units or fuse units rated 10 amperes or larger shall be helically coiled to avoid mechanical damage due to stresses from current surges.

- 2.9.1.4 Fusible elements, that carry continuous current, shall be supported in air to help prevent damage from current surges.
- 2.9.1.5 Each refill unit or fuse unit shall have a single fusible element to eliminate the possibility of unequal current sharing in parallel current paths.
- 2.9.1.6 Solid-material power fuses shall have melting time-current characteristics that are permanently accurate to within a maximum total tolerance of 10% in terms of current. Time-current characteristics shall be available which permit coordination with protective relays, automatic circuit reclosers, and other fuses.
- 2.9.1.7 Solid-material power fuses shall be capable of detecting and interrupting all faults whether large, medium, or small (down to minimum melting current), under all realistic conditions of circuitry, with line-to-line or line-to-ground voltage across the fuse, and shall be capable of handling the full range of transient recovery voltage severity associated with these faults.
- 2.9.1.8 All arcing accompanying operation of solid-material power fuses shall be contained within the fuse, and all arc products and gases evolved shall be effectively contained within the exhaust control device during fuse operation.
- 2.9.1.9 Solid-material power fuses shall be equipped with a blown-fuse indicator that shall provide visible evidence of fuse operation while installed in the fuse mounting.
- 2.9.2 Fuse-mounting jaw contacts shall incorporate an integral load interrupter that shall permit live switching of fuses with a hookstick.
- 2.9.2.1 The integral load interrupter housing shall be of the same cycloaliphatic epoxy resin as the insulators.
- 2.9.2.2 The integral load interrupter shall be in the current path continuously. Auxiliary blades or linkages shall not be used.

- 2.9.2.3 Live switching shall be accomplished by a firm, steady opening pull on the fuse pull ring with a hookstick. No separate load-interrupting tool shall be required.
- 2.9.2.4 The integral load interrupter shall require a hard pull to unlatch the fuse to reduce the possibility of an incomplete opening operation.
- 2.9.2.5 Internal moving contacts of the integral load interrupter shall be self-resetting after each opening operation to permit any subsequent closing operation to be performed immediately.
- 2.9.2.6 Circuit interruption shall take place completely within the integral load interrupter with no external arc or flame.
- 2.9.2.7 The integral load interrupter and the fuse shall be provided with separate fault-closing contacts and current-carrying contacts. The fuse hinge shall be self-guiding and, together with the fault-closing contacts, shall guide the fuse into the current-carrying contacts during closing operations. Circuit-closing inrush currents and fault currents shall be picked up by the fault-closing contacts, not by the current-carrying contacts or interrupting contacts.
- 2.9.2.8 Integral load interrupters for fuses shall have a one-time duty-cycle fault-closing capability equal to the interrupting rating of the fuse, and a two-time duty-cycle fault-closing capability of 13,000 amperes rms asymmetrical at 14.4 kv or 25 kv. The duty-cycle fault-closing capability defines the level of available fault current into which the fuse can be closed the specified number of times (once or twice), without a quick-make mechanism and when operated vigorously through its full travel without hesitation at any point, with the integral load interrupter remaining operable and able to carry and interrupt currents up to the emergency peak-load capabilities of the fuse.
- 2.9.3 Fuse terminal pads shall be provided with a two-position adapter, making it possible to accommodate a variety of cable-terminating devices.
- 2.9.4 Ground studs shall be provided at all fuse terminals. One ground stud shall also be provided on the ground pad in each fuse compartment. The momentary rating of

the ground studs shall equal or exceed the short-circuit ratings of the pad-mounted gear.

2.9.5 Cable guides shall be provided to help orient cables at fuse terminals.

2.9.6 A fuse-storage compartment shall be provided in (one, two) source interrupter-switch compartment(s). Each fuse-storage compartment shall provide space for storing three spare fuse holders or fuse units with end fittings for solid-material power fuses, or two spare electronic power fuse holders.

## 2.10 **Warning Signs**

2.10.1 All external doors shall be provided with "Caution-High Voltage-Keep Out" signs.

2.10.2 The inside of each door shall be provided with a "Danger-High Voltage-Keep Out-Qualified Persons Only" sign.

2.10.3 The inside of each door providing access to an interrupter switch shall be provided with a warning sign indicating that "Switch Blades May Be Energized in Any Position."

2.10.4 The inside of each door providing access to fuses shall be provided with a warning sign indicating that "Fuses May Be Energized in Any Position."

2.10.5 Any barriers used to prevent access to energized live parts shall be provided with "Danger-High Voltage-Keep Out-Qualified Persons Only" signs.

## 2.11 **Nameplates, Ratings Labels, and Connection Diagrams**

2.11.1 The outside of each door (or set of double doors) shall be provided with a nameplate indicating the manufacturer's name, catalog number, model number, date of manufacture, and serial number.

2.11.2 The inside of each door (or set of double doors) shall be provided with a ratings label indicating the following: voltage ratings; main bus continuous rating; short-circuit ratings (amperes rms symmetrical and Mva three-phase symmetrical at rated nominal voltage); the type of fuse and its ratings including

duty-cycle fault-closing capability; and interrupter switch ratings including duty-cycle fault-closing and short-time (momentary, amperes rms asymmetrical and one-second, amperes rms symmetrical).

- 2.11.3 A three-line connection diagram showing interrupter switches, fuses with integral load interrupter, and bus along with the manufacturer's model number shall be provided on the inside of each door (or set of double doors), and on the inside of each switch-operating-hub access cover.

### **PART 3. EXECUTION**

- 3.1 Verify of existing conditions prior to beginning work.

- 3.2 Verify that support pads are ready to receive Products.

- 3.3 INSTALLATION

- 3.3.1 Install in accordance with IEEE C57.94.

- 3.3.2 Install substation plumb and level and with each section aligned properly.

- 3.3.3 Make electrical connections between equipment sections using connectors furnished by manufacturer.

- 3.4 FIELD QUALITY CONTROL

- 3.4.1 Inspection and test in accordance with NETA ATS, except Section 4.

- 3.4.2 Primary Switch: Perform inspections and tests listed in NETA ATS, Section 7.5

END OF SECTION

## **SECTION 16452 - GROUNDING**

### **PART 1. GENERAL**

#### **1.1. RELATED DOCUMENTS:**

- 1.1.1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### **1.2. SUMMARY:**

- 1.2.1. This Section includes grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other Sections of these Specifications.
- 1.2.2. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1.2.2.1. Division 16 Section "Wires and Cables" for requirements for grounding conductors.

#### **1.3. SUBMITTALS:**

- 1.3.1. Product Data for grounding rods, connectors and connection materials, and grounding fittings.

#### **1.4. QUALITY ASSURANCE:**

- 1.4.1. Comply with NFPA 70.
- 1.4.2. Comply with UL 467.
- 1.4.3. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
  - 1.4.3.1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
  - 1.4.3.2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

### **PART 2. PRODUCTS**

#### **2.1. MANUFACTURERS:**

- 2.1.1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the

following:

- 2.1.1.1. Apache Grounding; Nashville Wire Products.
- 2.1.1.2. Boggs: H. L. Boggs & Co.
- 2.1.1.3. Chance: A. B. Chance Co.
- 2.1.1.4. Dossert Corp.
- 2.1.1.5. Erico Inc.; Electrical Products Group.
- 2.1.1.6. Galvan Industries, Inc.
- 2.1.1.7. Hastings Fiber Glass Products, Inc.
- 2.1.1.8. Heary Brothers Lightning Protection Co.
- 2.1.1.9. Ideal Industries, Inc.
- 2.1.1.10. ILSCO.
- 2.1.1.11. Kearney.
- 2.1.1.12. Korn: C. C. Korn Co.
- 2.1.1.13. Lightning Master Corp.
- 2.1.1.14. Lyncole XIT Grounding.
- 2.1.1.15. O-Z/Gedney Co.
- 2.1.1.16. Raco, Inc.
- 2.1.1.17. Salisbury: W.H. Salisbury & Co., Utility.
- 2.1.1.18. Thomas & Betts, Electrical.
- 2.1.1.19. Utilco Co.

2.2. **GROUNDING AND BONDING PRODUCTS:**

- 2.2.1. Governing Requirements: Where types, sizes, ratings, and quantities indicated are in excess of National Electrical Code (NEC) requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

2.3. **WIRE AND CABLE GROUNDING CONDUCTORS:**

- 2.3.1. Comply with Division 16 Section "Wires and Cables." Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.
- 2.3.1.1. Material: copper. Use only copper wire for both insulated and

bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

- 2.3.2. Equipment Grounding Conductors: Insulated with green color insulation.
- 2.3.3. Grounding-Electrode Conductors: Stranded cable.
- 2.3.4. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.
- 2.3.5. Bare Copper Conductors: Conform to the following:
  - 2.3.5.1. Solid Conductors: ASTM B 3.
  - 2.3.5.2. Assembly of Stranded Conductors: ASTM B 8.
  - 2.3.5.3. Tinned Conductors: ASTM B 33.
- 2.4. **MISCELLANEOUS CONDUCTORS:**
  - 2.4.1. Grounding Bus: Bare, annealed-copper bars of rectangular cross section.
  - 2.4.2. Braided Bonding Jumpers: Copper tape, braided No. 30 AWG bare copper wire, terminated with copper ferrules.
  - 2.4.3. Bonding Straps: Soft copper, 0.05 inch (1 mm) thick and 2 inches (50 mm) wide, except as indicated.
- 2.5. **CONNECTOR PRODUCTS:**
  - 2.5.1. Pressure Connectors: High-conductivity-plated units.
  - 2.5.2. Bolted Clamps: Heavy-duty type.
  - 2.5.3. Exothermic-Welded Connections: Provided in kit form and selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.
- 2.6. **GROUNDING ELECTRODES AND TEST WELLS:**
  - 2.6.1. Grounding Rods: Copper-clad steel.
    - 2.6.1.1. Size: 5/8 inch by 96 inches (16 by 2400 mm).

### **PART 3. EXECUTION**

- 3.1. **APPLICATION:**
  - 3.1.1. Equipment Grounding Conductors: Comply with NEC Article 250 for types, sizes, and quantities of equipment grounding conductors, except where specific types, larger sizes, or more conductors than required by NEC are indicated.

- 3.1.1.1. Install equipment grounding conductor with circuit conductors for the items below in addition to those required by Code:
  - 3.1.1.1.1. Feeders and branch circuits.
  - 3.1.1.1.2. Receptacle circuits.
  - 3.1.1.1.3. Single-phase motor or appliance branch circuits.
  - 3.1.1.1.4. Three-phase motor or appliance branch circuits.
  - 3.1.1.1.5. Flexible raceway runs.
- 3.1.1.2. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
- 3.1.1.3. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and above, including air cleaners and heaters. Bond conductor to each unit and to air duct.
- 3.1.1.4. Water Heater, Heat-Tracing, and Antifrost Heater Circuits: Install a separate equipment grounding conductor to each electric water heater, heat-tracing assembly, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.
- 3.1.2. Separately Derived Systems: Where NEC requires grounding, ground according to NEC Paragraph 250-26.
- 3.2. **INSTALLATION:**
  - 3.2.1. General: Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.
  - 3.2.2. Grounding Rods: Locate a minimum of 1-rod length from each other and at least the same distance from any other grounding electrode.
    - 3.2.2.1. Drive until tops are 2 inches (50 mm) below finished floor or final grade, except as otherwise indicated.
    - 3.2.2.2. Interconnect with grounding-electrode conductors. Use exothermic welds, except as otherwise indicated. Make these connections without damaging copper coating or exposing steel.
  - 3.2.3. Grounding Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
  - 3.2.4. Underground Grounding Conductors: Use bare copper wire. Bury at least 24 inches (600 mm) below grade.

- 3.2.5. Metal Water Service Pipe: Provide insulated copper grounding conductors, sized as indicated, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding-clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Do not install a grounding jumper across dielectric fittings. Bond grounding-conductor conduit to conductor at each end.
- 3.2.6. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding-clamp connectors.
- 3.2.7. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.
- 3.3. **CONNECTIONS:**
- 3.3.1. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
- 3.3.1.1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
- 3.3.1.2. Make connections with clean, bare metal at points of contact.
- 3.3.1.3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- 3.3.2. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- 3.3.3. Equipment Grounding-Wire Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- 3.3.4. Noncontact Metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors, except as

otherwise indicated.

- 3.3.5. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.
- 3.3.6. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- 3.3.7. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.4. **UNDERGROUND DISTRIBUTION SYSTEM GROUNDING:**

- 3.4.1. Manholes and Handholes: Install a driven grounding rod close to wall and set rod depth so 4 inches (100 mm) will extend above finished floor. Where necessary, install grounding rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from grounding rod into manhole through a waterproof sleeve in manhole wall. Protect grounding rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- 3.4.2. Connections to Manhole Components: Connect exposed metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to grounding rod or grounding conductor. Make connections with minimum No. 4 AWG stranded, hard-drawn copper wire. Train conductors plumb or level around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- 3.4.3. Grounding System: Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes.

3.5. **FIELD QUALITY CONTROL:**

- 3.5.1. Tests: Subject the completed grounding system to a megger test at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than 2 full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform

tests by the 2- point method according to IEEE 81.

3.5.2. Maximum grounding to resistance values are as follows:

3.5.2.1. Equipment Rated 500 kVA and Less: 10 ohms.

3.5.2.2. Equipment Rated 500 to 1000 kVA: 5 ohms.

3.5.2.3. Equipment Rated More than 1000 kVA: 3 ohms.

3.5.2.4. Unfenced Substations and Pad-Mounted Equipment: 5 ohms.

3.5.2.5. Manhole Grounds: 10 ohms.

3.5.3. Excessive Ground Resistance: Where resistance to ground exceeds specified values, notify Owner promptly and include recommendations to reduce ground resistance and to accomplish recommended work.

3.5.4. Report: Prepare test reports, certified by the testing organization, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

3.6. **ADJUSTING AND CLEANING:**

3.6.1. Restore surface features, including vegetation, at areas disturbed by work of this Section. Reestablish original grades, except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 2 Section "Landscaping." Maintain restored surfaces. Restore disturbed paving as indicated.

## **SECTION 16470 - PANELBOARDS**

### **PART 1. GENERAL**

#### **1.1. SUMMARY:**

- 1.1.1. This Section includes lighting and power panelboards and associated auxiliary equipment rated 600 V and less.
- 1.1.2. Related Sections include the following:
  - 1.1.2.1. Division 16 Section "Basic Electrical Materials and Methods" for general materials and installation methods.
  - 1.1.2.2. Division 16 Section "Electrical Identification" for labeling materials.

#### **1.2. SUBMITTALS:**

- 1.2.1. Product Data: For each type of panelboard, accessory item, and component specified.

#### **1.3. QUALITY ASSURANCE:**

- 1.3.1. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
  - 1.3.1.1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
  - 1.3.1.2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- 1.3.2. Comply with NFPA 70.
- 1.3.3. Comply with NEMA PB 1.

#### **1.4. EXTRA MATERIALS**

- 1.4.1. Keys: 3 spares for each type of panelboard cabinet lock.

### **PART 2. PRODUCTS**

#### **2.1. MANUFACTURERS:**

- 2.1.1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2.1.1.1. Eaton Corp.; Westinghouse & Cutler-Hammer Products.
  - 2.1.1.2. General Electric Co.; Electrical Distribution & Control Div.

2.1.1.3. Siemens Energy & Automation, Inc.

2.1.1.4. Square D Co.

2.2. **PANELBOARD FABRICATION:**

2.2.1. Enclosures: Surface-mounted cabinets as indicated. NEMA PB 1, Type 1, unless otherwise indicated to meet environmental conditions at installed location.

2.2.2. Front: Secured to box with concealed trim clamps, unless otherwise indicated. Front for surface-mounted panelboards shall be same dimensions as box. Front shall be hinged door in door.

2.2.3. Directory Frame: Metal, mounted inside each panelboard door. Directory shall be typed out.

2.2.4. Bus: Hard drawn copper of 98 percent conductivity.

2.2.5. Main and Neutral Lugs: Compression type.

2.2.6. Equipment Ground Bus: Adequate for feeder and branch- circuit equipment ground conductors. Bonded to box.

2.2.7. Service Equipment Approval: Listed for use as service equipment for panelboards with main service disconnect.

2.2.8. Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the overcurrent protective device ampere ratings indicated for future installation of devices.

2.2.9. Special Features: Include the following features for panelboards as indicated:

2.2.9.1. Hinged Front Cover: Entire front trim hinged to box with standard door within hinged trim cover.

2.3. **DISTRIBUTION PANELBOARDS:**

2.3.1. Doors: In panelboard front, unless otherwise indicated. Secure door with vault-type latch with tumbler lock, all keyed alike.

2.3.2. Branch-Circuit Breakers: Where overcurrent protective devices are indicated to be circuit breakers, use bolt-on circuit breakers.

2.4. **OVERCURRENT PROTECTIVE DEVICES:**

2.4.1. Molded-Case Circuit Breaker: NEMA AB 1, handle lockable.

2.4.1.1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.

- 2.4.1.2. Application Listing: Appropriate for application, including Type SWD for switching fluorescent lighting loads and Type HACR for heating, air-conditioning, and refrigerating equipment.
- 2.4.1.3. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.
- 2.4.1.4. Circuit Breakers, 400 A and Larger: Field-adjustable short-time and continuous current settings.
- 2.4.1.5. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
- 2.4.1.6. Shunt Trip: Where indicated.

### **PART 3. EXECUTION**

#### **3.1. INSTALLATION:**

- 3.1.1. Install panelboards and accessory items according to NEMA PB 1.1.
- 3.1.2. Mounting Heights: Top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.
- 3.1.3. Mounting: Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.
- 3.1.4. Circuit Directory: Type directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing.
- 3.1.5. Install filler plates in unused spaces.
- 3.1.6. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with wire ties after completing load balancing.

#### **3.2. IDENTIFICATION:**

- 3.2.1. Identify field-installed wiring and components and provide warning signs as specified in Division 16 Section "Basic Electrical Materials and Methods."
- 3.2.2. Identify field-installed wiring and components and provide warning signs as specified in Division 16 Section "Electrical Identification."
- 3.2.3. Panelboard Nameplates: Label each panelboard with engraved laminated-plastic or metal nameplates mounted with corrosion-resistant screws.

#### **3.3. GROUNDING:**

- 3.3.1. Make equipment grounding connections for panelboards as

indicated.

- 3.3.2. Provide ground continuity to main electrical ground bus as indicated.

- 3.4. **CONNECTIONS:**

- 3.4.1. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

- 3.5. **FIELD QUALITY CONTROL:**

- 3.5.1. Prepare for acceptance tests as follows:
  - 3.5.1.1. Make insulation-resistance tests of each panelboard bus, component, and connecting supply, feeder, and control circuits.
- 3.5.2. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
  - 3.5.2.1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
  - 3.5.2.2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.
- 3.5.3. Balancing Loads: After Substantial Completion, but not more than 2 months after Final Acceptance, conduct load-balancing measurements and make circuit changes as follows:
  - 3.5.3.1. Perform measurements during period of normal working load as advised by Owner.
  - 3.5.3.2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility. Make special arrangements with Owner to avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
  - 3.5.3.3. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
  - 3.5.3.4. Tolerance: Difference exceeding 10 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as required to meet this minimum requirement.

- 3.6. **ADJUSTING:**

3.6.1. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.7. **CLEANING:**

3.7.1. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

## **SECTION 16475 - FUSES**

### **PART 1. GENERAL**

#### **1.1. RELATED DOCUMENTS:**

- 1.1.1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### **1.2. SUMMARY:**

- 1.2.1. This Section includes the following:

- 1.2.1.1. Fuses.

#### **1.3. SUBMITTALS:**

- 1.3.1. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- 1.3.2. Product Data for each fuse type specified.

#### **1.4. QUALITY ASSURANCE:**

- 1.4.1. Source Limitations: Obtain fuses from one source and by a single manufacturer.
- 1.4.2. Comply with NFPA 70 for components and installation.
- 1.4.3. Listing and Labeling: Provide fuses specified in this Section that are listed and labeled.
  - 1.4.3.1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
  - 1.4.3.2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

### **PART 2. PRODUCTS**

#### **2.1. MANUFACTURERS:**

- 2.1.1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering fuses that may be incorporated into the Work include, but are not limited to, the following:
  - 2.1.1.1. Cooper Industries, Inc.; Bussmann Div.
  - 2.1.1.2. Eagle Electric Mfg. Co., Inc.

- 2.1.1.3. Ferraz Corp.
- 2.1.1.4. General Electric Co.; Wiring Devices Div.
- 2.1.1.5. Gould Shawmut.
- 2.1.1.6. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.2. **CARTRIDGE FUSES:**

- 2.2.1. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class as specified or indicated; current rating as indicated; voltage rating consistent with circuit voltage.

**PART 3. EXECUTION**

3.1. **EXAMINATION:**

- 3.1.1. Examine utilization equipment nameplates and installation instructions to verify proper fuse locations, sizes, and characteristics.
- 3.1.2. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2. **FUSE APPLICATIONS:**

- 3.2.1. Main Service: Class L, fast acting.
- 3.2.2. Main Feeders: Class J, time delay.
- 3.2.3. Motor Branch Circuits: Class RK1, time delay.
- 3.2.4. Other Branch Circuits: Class RK5, non-time delay.

3.3. **INSTALLATION:**

- 3.3.1. Install fuses in fusible devices as indicated. Arrange fuses so fuse ratings are readable without removing fuse.
- 3.3.2. Install spare fuse cabinet where indicated.

3.4. **IDENTIFICATION:**

- 3.4.1. Install typewritten labels on inside door of each fused switch to indicate fuse replacement information.

## **SECTION 16476 - DISCONNECT SWITCHES AND CIRCUIT BREAKERS**

### **PART 1. GENERAL**

#### **1.1. RELATED DOCUMENTS:**

- 1.1.1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### **1.2. SUMMARY:**

- 1.2.1. This Section includes individually mounted switches and circuit breakers used for the following:
  - 1.2.1.1. Service disconnect switches.
  - 1.2.1.2. Feeder and equipment disconnect switches.
  - 1.2.1.3. Feeder branch-circuit protection.
  - 1.2.1.4. Motor disconnect switches.
- 1.2.2. Related Sections: The following Sections contain requirements that relate to this Section:

#### **1.3. SUBMITTALS:**

- 1.3.1. Product Data for switches and accessories specified in this Section. Include the following:
- 1.3.2. Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.

#### **1.4. QUALITY ASSURANCE:**

- 1.4.1. Source Limitations: Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.
- 1.4.2. Comply with NFPA 70 for components and installation.
- 1.4.3. Listing and Labeling: Provide disconnect switches and circuit breakers specified in this Section that are listed and labeled.
  - 1.4.3.1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
  - 1.4.3.2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

## **PART 2. PRODUCTS**

### **2.1. DISCONNECT SWITCHES:**

- 2.1.1. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle.
- 2.1.2. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position.
- 2.1.3. Enclosure: NEMA KS 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.
  - 2.1.3.1. Outdoor Locations: Type 3R.
  - 2.1.3.2. Kitchen Areas: Type 4X, stainless steel.
  - 2.1.3.3. Other Wet or Damp Indoor Locations: Type 4.
  - 2.1.3.4. Hazardous Areas Indicated on Drawings: Type 7C.

### **2.2. ENCLOSED CIRCUIT BREAKERS:**

- 2.2.1. Enclosed, Molded-Case Circuit Breaker: NEMA AB 1, with lockable handle.
- 2.2.2. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting rating to meet available fault current.
- 2.2.3. Application Listing: Appropriate for application, including switching fluorescent lighting loads or heating, air-conditioning, and refrigerating equipment.
- 2.2.4. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.
- 2.2.5. Circuit Breakers, 400 A and Larger: Field-adjustable, short-time and continuous-current settings.
- 2.2.6. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.
- 2.2.7. Current Limiters: Where indicated, integral fuse listed for circuit breaker.
- 2.2.8. Molded-Case Switch: Where indicated, molded-case circuit breaker without trip units.
- 2.2.9. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
- 2.2.10. Accessories: As indicated.

- 2.2.11. Enclosure: NEMA AB 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.
- 2.2.11.1. Outdoor Locations: Type 3R.
- 2.2.11.2. Kitchen Areas: Type 4X, stainless steel.
- 2.2.11.3. Other Wet or Damp Indoor Locations: Type 4.
- 2.2.11.4. Hazardous Areas Indicated on Drawings: Type 7C.
- 2.2.12. Transient Voltage Surge Suppressors: IEEE C62.41, to meet requirements for category indicated.
- 2.2.12.1. Exposure: Low.
- 2.2.12.2. Exposure: Medium.
- 2.2.12.3. Exposure: High.
- 2.2.12.4. Impulse sparkover voltage coordinated with system circuit voltage.
- 2.2.12.5. Factory mounted with UL-recognized mounting device.

### **PART 3. EXECUTION**

#### **3.1. INSTALLATION:**

- 3.1.1. Install disconnect switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.
- 3.1.2. Install disconnect switches and circuit breakers level and plumb.
- 3.1.3. Install wiring between disconnect switches, circuit breakers, control, and indication devices.
- 3.1.4. Connect disconnect switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer.
- 3.1.4.1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- 3.1.5. Identify each disconnect switch and circuit breaker according to requirements specified in Division 16 Section "Basic Electrical Materials and Methods."
- 3.1.6. Identify each disconnect switch and circuit breaker according to requirements specified in Division 16 Section "Electrical Identification."

#### **3.2. FIELD QUALITY CONTROL:**

- 3.2.1. Testing: After installing disconnect switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
- 3.2.1.1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for disconnect switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
- 3.2.2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.
- 3.3. **ADJUSTING:**
- 3.3.1. Set field-adjustable disconnect switches and circuit-breaker trip ranges as indicated.
- 3.4. **CLEANING:**
- 3.4.1. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

## **SECTION 16495 - TRANSFER SWITCHES**

### **PART 1. GENERAL**

#### 1.1. RELATED DOCUMENTS

- 1.1.1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2. **SUMMARY:**

- 1.2.1. This Section includes transfer switches rated 600 V and less and the following items:

- 1.2.1.1. Automatic transfer switch.
  - 1.2.1.2. Remote annunciation system.

- 1.2.2. Related Sections include the following:

#### 1.3. **SUBMITTALS:**

- 1.3.1. Product Data: For each switch specified. Include dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and materials lists.
- 1.3.2. Wiring Diagrams: Details of wiring for transfer switches and differentiating between manufacturer-installed and field-installed wiring. Show both power and control wiring.
- 1.3.3. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

#### 1.4. **QUALITY ASSURANCE:**

- 1.4.1. Emergency Service: Manufacturer maintains a service center capable of providing emergency maintenance and repairs at Project site with an 8-hour maximum response time.
- 1.4.2. Source Limitations: Obtain automatic transfer switch, and remote annunciator from a single manufacturer who assumes responsibility for all components.
- 1.4.3. Listing and Labeling: Provide transfer switches specified in this Section that are listed and labeled for emergency service under UL 1008.
  - 1.4.3.1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

- 1.4.3.2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- 1.4.4. Comply with NFPA 70.
- 1.4.5. UL Compliance: Comply with UL 1008, "Automatic Transfer Switches," unless requirements of these Specifications are stricter.

## **PART 2. PRODUCTS**

### **2.1. GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS:**

- 2.1.1. Units Smaller than 600 A: Listed without derating for all classes and all mixtures of classes of loads, including 100 percent tungsten filament lamp or 100 percent inductive load.
- 2.1.2. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated based on testing according to UL 1008.
  - 2.1.2.1. Where External Circuit Breaker or Fuses Protect Transfer Switch: Products are listed for use with the actual devices providing the fault-current protection at each location for Project. Rated fault-current, withstand- duration times include the following:
    - 2.1.2.1.1. Units Protected by Molded-Case Circuit Breakers 150 A and Less: 1.5 cycles.
    - 2.1.2.1.2. Units Protected by Molded-Case Circuit Breakers Larger than 150 A: 3 cycles.
    - 2.1.2.1.3. Units Protected by Power and Insulated-Case Circuit Breakers: 10 cycles.
    - 2.1.2.1.4. Units Protected by Current-Limiting Fuses: 0.5 cycles (nominal).
  - 2.1.2.2. Where Transfer Switch Includes Internal Protection: Rating of switch and trip unit combination exceeds indicated fault-current value at installation location.
- 2.1.3. Annunciation and Control Interface Components: Devices at transfer switches for communicating with remote annunciators or annunciator and control panels have communications capability matched with the remote device.
- 2.1.4. Solid-State Controls: Repetitive accuracy of all settings is plus or minus 2 percent or better over an operating temperature range of minus 20 deg C to 70 deg C.
- 2.1.5. Resistance to Damage by Voltage Transients: Components meet or exceed voltage-surge withstand capability requirements when tested according to ANSI C37.90.1. Components meet or exceed

voltage-impulse withstand test of NEMA ICS 1.

- 2.1.6. Neutral Terminal: Where 2- or 3-pole switches are indicated, provide fully rated, solid, unswitched neutral terminal, unless otherwise indicated.
- 2.1.7. Four-Pole Switches: Where 4-pole switches are indicated, provide neutral switching.
- 2.1.8. Enclosures: General-purpose NEMA 250, Type 3R, complying with NEMA ICS 6; UL 508, unless otherwise indicated.
- 2.1.9. Heater: Equip switches exposed to outdoor temperature and humidity conditions, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.
- 2.1.10. Factory Wiring: Train and bundle factory wiring and label consistent with Shop Drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.
  - 2.1.10.1. Designated Terminals: Pressure type suitable for types and sizes of field wiring indicated.
  - 2.1.10.2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
  - 2.1.10.3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- 2.1.11. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric motor-operated mechanism, mechanically and electrically interlocked in both directions.
- 2.1.12. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
  - 2.1.12.1. Limitation: Switches using molded-case switch or insulated-case circuit-breaker components and switches using contactors not designed for continuous-duty repetitive switching between active power sources are not acceptable.
  - 2.1.12.2. Switch Action: Double throw; mechanically held in both directions.
  - 2.1.12.3. Switch Contacts: Silver composition for load current switching. Conventional automatic transfer-switch units rated 225 A and greater have separate arcing contacts.
- 2.2. **AUTOMATIC TRANSFER SWITCH:**
  - 2.2.1. Comply with Level 1 equipment according to NFPA 110.
  - 2.2.2. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

- 2.2.3. Manual Switch Operation: Manually operated under load, with the door closed, and with either or both sources energized. Transfer time is the same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
- 2.2.4. Signal-before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
- 2.2.5. Transfer Switches Based on Molded-Case Switch Components: Comply with UL 489, UL 869, and NEMA AB 1.
- 2.3. **AUTOMATIC TRANSFER-SWITCH FEATURES:**
  - 2.3.1. Voltage sensing for each phase of normal source. Pickup voltage is adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
  - 2.3.2. Time delay for override of normal-source voltage sensing delays transfer and engine start signals. Adjustable 0 to 6 seconds and factory set at 1 second.
  - 2.3.3. Voltage/Frequency Lockout Relay: Prevents premature transfer to an emergency generator set. Pickup voltage is adjustable from 85 to 100 percent of nominal. Factory set to pickup at 90 percent. Pickup frequency is adjustable from 90 to 100 percent of nominal. Factory set to pickup at 95 percent.
  - 2.3.4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes and factory set at 10 minutes. Provides automatic defeat of the delay on loss of voltage or sustained undervoltage of the emergency source, provided normal supply has been restored.
  - 2.3.5. Test Switch: Simulates normal-source failure.
  - 2.3.6. Switch-Position Pilot Lights: Indicate source to which load is connected.
  - 2.3.7. Source-Available Indicating Lights: Supervise sources via the transfer-switch, normal- and emergency-source sensing circuits.
    - 2.3.7.1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    - 2.3.7.2. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
  - 2.3.8. Unassigned Auxiliary Contacts: 2 normally open single-pole, double-throw contacts for each switch position, rated 10 A at 240 V, ac.

- 2.3.9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of the condition of the normal source. A pilot light indicates override status.
- 2.3.10. Engine Starting Contacts: 1 isolated, normally closed and 1 isolated, normally open. Contacts are gold flashed or gold plated and rated 10 A at 32 V, dc minimum.
- 2.3.11. Engine Shutdown Contacts: Time delay adjustable from 0 to 5 minutes; factory set at 5 minutes. Initiates shutdown at remote engine-generator controls after retransfer of load to normal source.
- 2.3.12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine-generator set and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory-set periods are for 7 days, 20 minutes, and 5 minutes, respectively. Exerciser features include the following:
  - 2.3.12.1. Exerciser Transfer Selector Switch: Permits selection between exercise with and without load transfer.
  - 2.3.12.2. Push-button programming control with digital display of settings.
  - 2.3.12.3. Integral battery operation of time switch when normal control power is not available.
- 2.4. **FINISHES:**
  - 2.4.1. Enclosures: Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.
- 2.5. **SOURCE QUALITY CONTROL:**
  - 2.5.1. Factory Test Components, Assembled Switches, and Associated Equipment: Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

### **PART 3. EXECUTION**

- 3.1. **INSTALLATION:**
  - 3.1.1. Floor Mounting of Switches: Level and anchor unit to floor.
  - 3.1.2. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.
  - 3.1.3. Identify components according to Division 16 Section "Electrical Identification."

- 3.1.4. Identify components according to Division 16 Section "Basic Electrical Materials and Methods."
- 3.2. **WIRING TO REMOTE COMPONENTS:**
  - 3.2.1. Match type and number of cables and conductors to control and communications requirements of transfer switches used. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- 3.3. **CONNECTIONS:**
  - 3.3.1. Ground equipment as indicated and required by National Electrical Code.
    - 3.3.1.1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- 3.4. **FIELD QUALITY CONTROL:**
  - 3.4.1. Preliminary Tests: Perform electrical tests as recommended by manufacturer and as follows:
    - 3.4.1.1. Measure phase-to-phase and phase-to-ground insulation resistance levels with insulation resistance tester. Include external annunciator and control circuits. Use test voltages and procedure recommended by manufacturer. Meet manufacturer's specified minimum resistance.
    - 3.4.1.2. Check for electrical continuity of circuits and for short circuits.
  - 3.4.2. Field Tests: Give 7 days' advance notice of tests and perform tests in presence of Owner's representative.
  - 3.4.3. Coordinate tests with tests of generator plant and run them concurrently.
  - 3.4.4. Tests: As recommended by manufacturer and as follows:
    - 3.4.4.1. Contact Resistance Test: Measure resistance of power contacts for automatic transfer switches, nonautomatic transfer switches, and bypass/isolation switches. Resolve values in excess of 500 micro-ohms and differences between adjacent poles exceeding 50 percent.
    - 3.4.4.2. Ground-Fault Tests: Coordinate with testing of ground- fault protective devices to ensure sensors are properly selected and located to optimize ground-fault protection when power is being delivered from either source.
      - 3.4.4.2.1. Verify grounding points and sensor ratings and locations.

- 3.4.4.2.2. Apply simulated fault current at sensors and observe reaction of circuit-interrupting devices.
- 3.4.4.3. Operational Tests: Demonstrate interlocking sequence and operational function for each switch at least 3 times.
  - 3.4.4.3.1. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
  - 3.4.4.3.2. Simulate low phase-to-ground voltage for each phase of normal source to automatic transfer switches.
  - 3.4.4.3.3. Verify time-delay settings and pickup and dropout voltages.
- 3.4.5. Test Failures: Correct deficiencies identified by tests and prepare for retest. Verify that equipment meets specified requirements.
- 3.4.6. Reports: Maintain a written record of observations and tests. Report defective materials and workmanship and retest corrected items. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- 3.5. **DEMONSTRATION:**
  - 3.5.1. Training: Engage a factory-authorized service representative to instruct Owner's personnel in the operation, maintenance, and adjustment of transfer switches and related equipment. Provide a minimum of 4 hours of instruction scheduled 7 days in advance.

## SECTION 16621 - PACKAGED ENGINE GENERATORS

### PART 1. GENERAL

#### 1.1. RELATED DOCUMENTS:

- 1.1.1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2. SUMMARY:

- 1.2.1. This Section includes packaged engine generator sets with the following features and accessories:
  - 1.2.1.1. Air-intake silencer.
  - 1.2.1.2. Battery charger.
  - 1.2.1.3. Day tank.
  - 1.2.1.4. Engine generator set.
  - 1.2.1.5. Muffler.
  - 1.2.1.6. Outdoor enclosure.
  - 1.2.1.7. Remote annunciator.
  - 1.2.1.8. Starting battery.
- 1.2.2. Related Sections include the following:
  - 1.2.2.1. Division 16 Section "Transfer Switches" for transfer switches, including sensors and relays to initiate automatic-starting and -stopping signals for engine generator sets.
- 1.3. DEFINITIONS:
  - 1.3.1. Standby Rating: Power output rating equal to the power the generator set delivers continuously under normally varying load factors for the duration of a power outage, with capability for a minimum overload of 10 percent of the rating for 2 out of 24 continuous operating hours.
  - 1.3.2. Operational Bandwidth: The total variation from the lowest to the highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
  - 1.3.3. Power Output Rating: Gross electrical power output of generator set minus total power requirements of electric motor-driven

cooling fan and pump.

- 1.3.4. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hz or cycles per second.

- 1.4. **GENERATOR-SET PERFORMANCE, NOMINAL:**

- 1.4.1. Steady-State Voltage Operational Bandwidth: 4 percent of rated output voltage from no load to full load.
- 1.4.2. Steady-State Voltage Modulation Frequency: Less than one Hz.
- 1.4.3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage recovers to remain within the steady-state operating band within 2 seconds.
- 1.4.4. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
- 1.4.5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there are no random speed variations outside the steady-state operational band and no hunting or surging of speed.
- 1.4.6. Transient Frequency Performance: Less than 2-Hz variation for a 50 percent step-load increase or decrease. Frequency recovers to remain within the steady-state operating band within 3 seconds.
- 1.4.7. Output Waveform: At no load, harmonic content measured line-to-line or line-to-neutral does not exceed 5 percent total and 3 percent for single harmonics. The telephone influence factor, determined according to NEMA MG 1, does not exceed 50.
- 1.4.8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at the system output terminals, the system will supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to any generator system component.
- 1.4.9. Temperature Rise of Generator: Within limits permitted by NEMA MG 1 when operating continuously at full-rated load, including 2 hours per 24 hours at 110 percent of rated capacity.
- 1.4.10. Starting Time: Maximum total time period for a cold start, with ambient temperature at the low end of the specified range, is 5 seconds. Time period includes output voltage and frequency settlement within specified steady-state bands.

- 1.5. **SUBMITTALS:**

- 1.5.1. Product Data: For each component. Include data on features, components, ratings, and performance. Include dimensioned outline plan and elevation drawings of engine generator set and

other system components.

- 1.5.2. Shop Drawings: Show details of fabrication, piping, wiring, and installation of field-installed portions of system. Include general arrangement drawings showing locations of auxiliary components in relation to engine generator set and duct, piping, and wiring connections between generator set and auxiliary equipment. Show connections, mounting, and support provisions and access and workspace requirements.
- 1.5.2.1. Wiring Diagrams: Show details of power and control connections and differentiating between factory- installed and field- installed wiring.
- 1.5.3. Qualification Data: For firms and persons specified in the "Quality Assurance" Article.
- 1.5.4. Field Test and Observation Reports: Indicate and interpret test results for compliance with performance requirements.
- 1.5.5. Certified summary of prototype-unit test report.
- 1.5.6. Certified Test Reports of Components and Accessories: For devices that are equivalent, but not identical, to those tested on prototype unit.
- 1.5.7. Certified Summary of Performance Tests: Demonstrate compliance with specified requirement to meet critical performance criteria.
- 1.5.8. Factory Test Reports: For units to be shipped for this Project showing evidence of compliance with specified requirements.
- 1.5.9. Exhaust Emissions Test Report: To show compliance with applicable regulations.
- 1.5.10. Sound measurement test report.
- 1.5.11. Certification of Torsional Vibration Compatibility: Comply with NFPA 110.
- 1.5.12. Field test report of tests specified in Part 3.
- 1.5.13. Maintenance data for system and components to include in the maintenance manuals specified in Division 1. Include the following:
  - 1.5.13.1. List of tools and replacement items recommended to be stored at the site for ready access. Include part and drawing numbers, current unit prices, and source of supply.
  - 1.5.13.2. Detail operating instructions for both normal and abnormal conditions.
- 1.6. **QUALITY ASSURANCE:**

- 1.6.1. Manufacturer Qualifications: Engage a firm experienced in manufacturing equipment of types and capacities similar to those indicated for this Project and with a service center maintained by engine generator set manufacturer capable of providing training, parts, and emergency maintenance and repairs at the Project site with 4 hours' maximum response time.
- 1.6.2. Source Limitations: Obtain engine generator set and auxiliary components from a single manufacturer with responsibility for entire system. Furnish a representative product built from components that have proven reliable and compatible with each other and are coordinated to operate as a unit as evidenced by records of prototype testing.
- 1.6.3. Listing and Labeling: Provide system components of types and ratings for which listing or labeling service is established and components specified in this Section that are listed and labeled.
  - 1.6.3.1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
  - 1.6.3.2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- 1.6.4. Comply with NFPA 70.
- 1.6.5. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- 1.7. **DELIVERY, STORAGE, AND HANDLING:**
  - 1.7.1. Deliver engine generator set and system components to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is safe from such hazards.
- 1.8. **WARRANTY:**
  - 1.8.1. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
  - 1.8.2. Special Warranty: Submit a written warranty signed by Contractor and manufacturer, with single-source responsibility for engine generator and auxiliary components, agreeing to repair or replace items that do not meet requirements or that deteriorate as defined in this Section within the specified warranty period.
  - 1.8.3. Warranty Period: 5 years from date of Substantial Completion.
- 1.9. **MAINTENANCE SERVICE:**

- 1.9.1. Maintenance: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of the manufacturer's designated service organization. Include quarterly exercising to check for proper, starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies as used in the manufacture and installation of original equipment.
- 1.10. **EXTRA MATERIALS:**
  - 1.10.1. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents. Deliver extra materials to Owner.
    - 1.10.1.1. Fuses: 1 for every 10 of each type and rating, but not less than 1 of each.
    - 1.10.1.2. Indicator Lamps: 2 for every 6 of each type used, but not less than 2 of each.
    - 1.10.1.3. Filters: One set each of lubricating oil, fuel, and combustion air filters.

## **PART 2. PRODUCTS**

- 2.1. **MANUFACTURERS:**
  - 2.1.1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - 2.1.1.1. Caterpillar, Inc.; Engine Division.
    - 2.1.1.2. Cooper Industries; Cooper Power Systems Division.
    - 2.1.1.3. Detroit Diesel.
    - 2.1.1.4. Generac Corporation.
    - 2.1.1.5. Kohler Company; Generator Division.
    - 2.1.1.6. MagneTek.
    - 2.1.1.7. Onan Corporation; Industrial Business Group.
- 2.2. **SERVICE CONDITIONS:**
  - 2.2.1. Environmental Conditions: Engine generator system withstands the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

- 2.2.1.1. Ambient Temperature: Minus 15 deg C to plus 40 deg C.
- 2.2.1.2. Relative Humidity: 0 to 95 percent.
- 2.2.1.3. Altitude: Sea level to 1000 feet (300 m).
- 2.3. **ENGINE GENERATOR:**
- 2.3.1. Furnish a coordinated assembly of compatible components.
- 2.3.2. Ratings: Voltage, frequency, and power output ratings of system are as indicated.
- 2.3.3. Output Connections: 208Y/120 volts, 60 Hertz 3 phase, 4 wire.
- 2.3.4. Safety Standard: Comply with ASME B15.1.
- 2.3.5. Nameplates: Each major system component is equipped with a conspicuous nameplate of component manufacturer. Nameplate identifies manufacturer of origin and address, and model and serial number of item.
- 2.3.6. Resistance to Seismic Forces: Supports for internal and external components, and fastenings for batteries, wiring, and piping are designed to withstand static or anticipated seismic forces, or both, in any direction. For each item, use a minimum force value equal to weight of item.
- 2.3.7. Limiting dimensions indicated for system components are not exceeded.
- 2.3.8. Power Output Rating: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.
- 2.3.9. Skid: Adequate strength and rigidity to maintain alignment of mounted components without dependence on a concrete foundation. Skid is free from sharp edges and corners. Lifting attachments are arranged to facilitate lifting with slings without damaging any components.
- 2.3.10. Rigging Diagram: Inscribed on a metal plate permanently attached to skid. Diagram indicates location and lifting capacity of each lifting attachment and location of center of gravity.
- 2.4. **ENGINE:**
- 2.4.1. Comply with NFPA 37.
- 2.4.2. Fuel: Diesel fuel oil grade DF-2.
- 2.4.3. Maximum Engine Speed: 1800 rpm.
- 2.4.4. Maximum Piston Speed for 2-Cycle Engines: 1725 fpm (8.8 m/s).

- 2.4.5. Maximum Piston Speed for 4-Cycle Engines: 2250 fpm (11.4 m/s).
- 2.4.6. Lubrication System: Pressurized by a positive-displacement pump driven from engine crankshaft. The following items are mounted on the engine or skid:
  - 2.4.6.1. Filter and Strainer: Rated to remove 90 percent of particles 5 microns and smaller while passing full flow.
  - 2.4.6.2. Oil Cooler: Maintains lubricating oil at manufacturer's recommended optimum temperature throughout 2 hours of operation of generator set at 110 percent of system power output rating.
  - 2.4.6.3. Thermostatic Control Valve: Controls flow in system to maintain optimum oil temperature. Unit is capable of full flow and is designed to be fail-safe.
  - 2.4.6.4. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without the use of pumps or siphons or special tools or appliances.
- 2.4.7. Engine Fuel System: Comply with NFPA 30. System includes the following:
  - 2.4.7.1. Integral Injection Pumps: Driven by engine camshaft. Pumps are adjustable for timing and cylinder pressure balancing.
  - 2.4.7.2. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
  - 2.4.7.3. Parallel Fuel Oil Filters: Ahead of injection pumps. Changeover valves allow independent use of either filter.
  - 2.4.7.4. Relief/Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- 2.4.8. Jacket Coolant Heater: Electric-immersion type, factory installed in jacket coolant system. Unit is rated and thermostatically controlled to maintain an engine temperature of 25 deg C at the low end of the ambient temperature range specified in "Environmental Conditions" Paragraph above.
- 2.5. **GOVERNOR:**
  - 2.5.1. Type: Adjustable isochronous type, with speed sensing.
- 2.6. **ENGINE COOLING SYSTEM:**
  - 2.6.1. Description: Closed loop, liquid cooled, with radiator factory mounted on engine generator-set skid and integral engine-driven coolant pumping.
  - 2.6.2. Radiator: Rated for specified coolant.
    - 2.6.2.1. Radiator Core Tubes: Nonferrous-metal construction other than

aluminum.

- 2.6.2.2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
- 2.6.2.3. Fan: Driven by multiple belts from engine shaft.
- 2.6.3. Coolant: Solution of 50 percent ethylene glycol and 50 percent water.
- 2.6.4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer. Features include the following:
  - 2.6.4.1. Thermostatic Elements: Interchangeable and nonadjustable.
  - 2.6.4.2. Actuator Design: Normally open valves to return to open position when actuator fails.
- 2.6.5. Coolant Hose: Flexible assembly with nonporous rubber inside surface and aging, ultraviolet, and abrasion-resistant fabric outer covering.
  - 2.6.5.1. Rating: 50-psig (345-kPa) maximum working pressure with 180 deg F (82 deg C) coolant, and noncollapsible under vacuum.
  - 2.6.5.2. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- 2.6.6. Coolant piping external to engine generator set is as specified in Division 15 Section "Hydronic Piping."

2.7. **FUEL SUPPLY SYSTEM:**

- 2.7.1. Comply with NFPA 30 and NFPA 37.
- 2.7.2. Base-Mounted Fuel Oil Tank: Factory-installed and -piped, listed and labeled fuel oil tank. Features include the following:
  - 2.7.2.1. Tank level indicator.
  - 2.7.2.2. Capacity: Fuel for 24 hours of continuous operation at 100 percent rated power output.
  - 2.7.2.3. Vandal-resistant fill cap.

2.8. **ENGINE EXHAUST SYSTEM:**

- 2.8.1. Muffler: Critical type, sized as recommended by engine manufacturer. Measured sound level, according to the Diesel Engine Manufacturers Association's "DEMA Test Code for the Measurement of Sound from Heavy-Duty Reciprocating Engines" at a distance of 10 feet (3 m) from the exhaust discharge, is 85 dBA or less.

- 2.8.2. Condensate Drain for Muffler: Schedule 40, black steel pipe connected to muffler drain outlet through a petcock.
- 2.8.3. Connections from Engine to Exhaust System: Flexible section of corrugated stainless-steel pipe.
- 2.8.4. Connection from Exhaust Pipe to Muffler: Stainless-steel expansion joint with liners.
- 2.8.5. Insulation for Mufflers and Indoor Exhaust Piping: As specified in Division 15 Section "Mechanical Insulation."
- 2.8.6. Supports for Muffler and Exhaust Piping: Spring hangers and all-thread rods as specified in Division 15 Section "Vibration Control"; attached to building structure.
- 2.8.7. Thimbles for Exhaust Piping: Comply with NFPA 211.
- 2.9. COMBUSTION AIR-INTAKE SYSTEM
  - 2.9.1. Air-Intake Silencer: Filter type providing filtration as recommended by engine manufacturer.
    - 2.9.1.1. Sound level emanating from air intake measured as specified in the Diesel Engine Manufacturers Association's "DEMA Test Code for the Measurement of Sound from Heavy-Duty Reciprocating Engines" at a distance of 25 feet (8 m) is 54 dBA or less in the 1200- to 4800-Hz frequency band and 56 dBA or less in the 4800- to 10,000-Hz band.
    - 2.9.1.2. Mounting: Factory installed on engine generator set at a location readily accessible for servicing.
  - 2.9.2. Intake Duct Connection: Size and connect intake duct to engine as recommended by manufacturer.
    - 2.9.2.1. Flexible Connector: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1; and factory fabricated with a strip of fabric 3-1/2 inches (89 mm) wide attached to 2 strips of 2-3/4-inch (70-mm) wide, 0.028-inch (0.7-mm), galvanized steel sheet or 0.032-inch (0.8-mm) aluminum sheets. Select metal compatible with connected duct system. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA's "HVAC Duct Construction Standards."
  - 2.9.3. Supports for Air-Intake Piping and Filter-Silencer Unit: Spring hangers and supports as specified in Division 15 Section "Vibration Control"; attached to building structure.
  - 2.9.4. Air-Intake Duct: Round ducts with 0.064-inch (1.6-mm) galvanized steel, with spiral lock-seam construction. Comply with SMACNA's "HVAC Duct Construction Standards."
- 2.10. **STARTING SYSTEM:**

- 2.10.1. Description: 24-V electric, with negative ground and including the following items:
  - 2.10.1.1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Environmental Conditions" Paragraph above.
  - 2.10.1.2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
  - 2.10.1.3. Cranking Cycle: As required by NFPA 110 for system level specified.
  - 2.10.1.4. Cranking Cycle: 60 seconds.
  - 2.10.1.5. Battery complies with SAE J537 and has adequate capacity within ambient temperature range specified in "Environmental Conditions" Paragraph above to provide specified cranking cycle at least twice without recharging.
  - 2.10.1.6. Battery Cable: Size as recommended by generator set manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
  - 2.10.1.7. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater is arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in "Environmental Conditions" Paragraph above. Include accessories required to support and fasten batteries in place.
  - 2.10.1.8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage-regulation and 35-A minimum continuous rating.
  - 2.10.1.9. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit complies with UL 508 and includes the following features:
    - 2.10.1.9.1. Operation: Equalizing-charging rate of 10 A is initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit then automatically switches to a lower float-charging mode and continues operating in that mode until battery is discharged again.
    - 2.10.1.9.2. Automatic Temperature Compensation: Adjusts float and equalizes voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
    - 2.10.1.9.3. Automatic Voltage Regulation: Maintains output voltage constant regardless of input voltage variations up to plus or minus 10 percent.

- 2.10.1.9.4. Ammeter and Voltmeter: Flush mounted in door. Meters indicate charging rates.
- 2.10.1.9.5. Safety Functions: Include sensing of abnormally low battery voltage arranged to close contacts providing low battery voltage indication on control and monitoring panel. Also include sensing of high battery voltage and loss of ac input or dc output of battery charger. Either of these conditions closes contacts that provide a battery charger malfunction indication at system control and monitoring panel.
- 2.10.1.9.6. Enclosure and Mounting: NEMA 250, Type 1, wall- mounted cabinet.

2.11. **CONTROL AND MONITORING:**

- 2.11.1. Functional Description: When the mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic-transfer switches initiate starting and stopping of the generator set. When the mode-selector switch is switched to the on position, the generator set manually starts. The off position of the same switch initiates generator-set shutdown. When the generator set is running, specified system or equipment failures or derangements automatically shut down the generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down the generator set.
- 2.11.2. Configuration: Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator circuit breaker, and other indicated components are grouped in a combination control and power panel. Control and monitoring section of panel is isolated from power sections by steel barriers. Panel features include the following:
  - 2.11.2.1. Wall-Mounted Cabinet Construction: Rigid, self- supporting steel unit conforming to NEMA ICS 6. Power bus is copper. Bus, bus supports, control wiring, and temperature rise comply with UL 891.
  - 2.11.2.2. Generator Circuit Breaker: Molded-case type with adjustable ground-fault tripping.
  - 2.11.2.3. Shunt Trip Device: For generator circuit breaker, connected to trip circuit breaker when generator set is shut down by protective devices.
  - 2.11.2.4. Current and Potential Transformers: Instrument accuracy class.
- 2.11.3. Indicating and Protective Devices, and Controls: Include the following:
  - 2.11.3.1. Ac voltmeter.
  - 2.11.3.2. Ac ammeter.

- 2.11.3.3. Ac frequency meter.
- 2.11.3.4. Dc voltmeter (alternator battery charging).
- 2.11.3.5. Engine-coolant temperature gage.
- 2.11.3.6. Engine lubricating-oil pressure gage.
- 2.11.3.7. Running-time meter.
- 2.11.3.8. Ammeter-voltmeter, phase-selector switch or switches.
- 2.11.3.9. Generator-voltage adjusting rheostat.
- 2.11.3.10. Start-stop switch.
- 2.11.3.11. Overspeed shutdown device.
- 2.11.3.12. Coolant high-temperature shutdown device.
- 2.11.3.13. Coolant low-level shutdown device.
- 2.11.3.14. Oil low-pressure shutdown device.
- 2.11.3.15. Fuel tank derangement alarm.
- 2.11.3.16. Fuel tank high-level shutdown of fuel supply alarm.
- 2.11.4. Supporting Items: Include sensors, transducers, terminals, relays, and other devices, and wiring required to support specified items. Locate sensors and other supporting items on engine, generator, or elsewhere as indicated. Where not indicated, locate to suit manufacturer's standard.
- 2.11.5. Common Remote Audible Alarm: Signal the occurrence of any of the events listed below without differentiating between different event types. Locate audible device and silencing means where indicated. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
  - 2.11.5.1. Engine high-temperature shutdown.
  - 2.11.5.2. Lube-oil low-pressure shutdown.
  - 2.11.5.3. Overspeed shutdown.
  - 2.11.5.4. Remote emergency-stop shutdown.
  - 2.11.5.5. Engine high-temperature prealarm.
  - 2.11.5.6. Lube-oil low-pressure prealarm.
  - 2.11.5.7. Fuel tank low level.

- 2.11.5.8. Overcrank shutdown.
- 2.11.5.9. Coolant low-temperature alarm.
- 2.11.5.10. Control switch not in auto position.
- 2.11.5.11. Battery-charger malfunction alarm.
- 2.11.5.12. Battery low-voltage alarm.
- 2.11.6. Remote Alarm Annunciator: Comply with NFPA 99. Labeled LEDs identify each alarm event. Common audible signal sounds for alarm conditions. Silencing switch in face of panel silences signal without altering visual indication. Connect so that after an alarm is silenced, clearing initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.
- 2.12. **GENERATOR, EXCITER, AND VOLTAGE REGULATOR:**
- 2.12.1. Comply with NEMA MG 1 and specified performance requirements.
- 2.12.2. Drive: Generator shaft is directly connected to engine shaft. Exciter is rotated integrally with generator rotor.
- 2.12.3. Electrical Insulation: Class H or Class F.
- 2.12.4. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- 2.12.5. Construction prevents mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- 2.12.6. Excitation uses no slip or collector rings, or brushes, and is arranged to sustain generator output under short-circuit conditions as specified.
- 2.12.7. Enclosure: Dripproof.
- 2.12.8. Instrument Transformers: Mounted within generator enclosure.
- 2.12.9. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
- 2.12.9.1. Adjusting rheostat on control and monitoring panel provides plus or minus 5 percent adjustment of output voltage operating band.
- 2.12.10. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- 2.12.11. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

2.12.12. Subtransient Reactance: 12 percent, maximum.

2.13. **OUTDOOR GENERATOR-SET ENCLOSURE:**

2.13.1. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels are lockable and provide adequate access to components requiring maintenance. Panels are removable by one person without tools. Instruments and control are mounted within enclosure.

2.13.1.1. Construction: Galvanized steel, metal-clad, integral structural-steel framed building erected on concrete foundation.

2.13.1.2. Structural Design and Anchorage: Adequate to resist loads imposed by 100-mph (160-km/h) wind.

2.13.1.3. Other structural loads, including roof, seismic, and auxiliary loads, are as indicated.

2.13.1.4. Louvers: Equipped with insect/rodent screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust and rodents.

2.13.1.5. Hinged Doors: With padlocking provisions.

2.13.1.6. Ventilation: Louvers equipped with insect/rodent screen and filter arranged to permit air circulation while excluding exterior dust and rodents.

2.13.1.7. Thermal Insulation: As required to maintain winter interior temperature within limits required by components.

2.13.1.8. Finish: 2-coat enamel finish over cleaned and primed surfaces.

2.13.2. Muffler Location: External to enclosure.

2.13.3. Engine Cooling Airflow through Enclosure: Adequate to maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at the top of the range specified in system service conditions.

2.13.4. Louvers: Fixed-engine cooling air inlet and discharge. Louvers prevent entry of rain and snow.

2.13.5. Automatic Dampers: At engine cooling air inlet and discharge. Dampers are closed to reduce enclosure heat loss in cold weather when unit is not operating.

2.13.6. Interior Lights: With switch. Factory-wired vaporproof- type fixtures within housing, arranged to illuminate controls and accessible interior. Arrange for external circuit supply.

2.13.7. Convenience Outlets: Factory wired. Arrange for external

circuit supply.

2.14. **FINISHES:**

2.14.1. Outdoor Enclosures: Manufacturer's standard enamel over corrosion-resistant pretreatment and compatible standard primer.

2.15. **SOURCE QUALITY CONTROL:**

2.15.1. Factory Tests: Include prototype testing and Project- specific equipment testing (testing of equipment manufactured specifically for this Project).

2.15.2. Prototype Testing: Performed on a separate engine generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

2.15.2.1. Tests: Conform to those required for Level 1 energy converters in paragraphs 3.2.1, 3.2.1.1, and 3.2.1.2 of NFPA 110.

2.15.2.2. Components and Accessories: Items furnished with installed unit that are not identical to those on tested prototype have been tested to demonstrate compatibility and reliability.

2.15.3. Project-Specific Equipment Tests: Factory test engine generator set and other system components and accessories before shipment. Test items individually and assembled and connected as a complete system the same as specified in "Field Quality Control" Article below. Record and report test data. Conform to the following:

2.15.3.1. Test Equipment: Use instruments calibrated within the previous 12 months and with accuracy directly traceable to the National Institute of Standards and Technology.

2.15.3.2. Hydrostatic Test: Perform on radiator, heat exchanger, and engine water jacket.

2.15.3.3. Generator Tests: Comply with IEEE 115.

2.15.3.4. Complete-System, Continuous-Operation Test: Include nonstop operation for a minimum of 8 hours, including at least 1 hour each at one-half, three-fourths, and full load, and 2 hours at 110 percent of full load. If unit stops during the 8-hour test, repeat the complete test. Record the following minimum data at start and end of each load run, at 15-minute intervals between those times, and at 15-minute intervals during balance of test:

2.15.3.4.1. Fuel consumption.

2.15.3.4.2. Exhaust temperature.

2.15.3.4.3. Jacket water temperature.

2.15.3.4.4. Lubricating oil temperature and pressure.

- 2.15.3.4.5. Generator load current and voltage, each phase.
- 2.15.3.4.6. Generator system gross and net output kW.
- 2.15.3.5. Complete-System Performance Tests: Include the following to demonstrate conformance to specified performance requirements:
  - 2.15.3.5.1. Single-step load pickup.
  - 2.15.3.5.2. Transient and steady-state governing.
  - 2.15.3.5.3. Transient and steady-state voltage performance.
  - 2.15.3.5.4. Safety shutdown devices.
- 2.15.3.6. Observation of Test: Provide 14 days' advance notice of tests and opportunity for observation of test by Owner's representatives.
- 2.15.3.7. Report test results within 10 days of completion of test.

### **PART 3. EXECUTION**

#### **3.1. INSTALLATION:**

- 3.1.1. Anchor generator set and other system components on concrete housekeeping bases conforming to Division 3 Section "Cast-in-Place Concrete" and as indicated. Provide anchorage according to manufacturer's written instructions, unless otherwise indicated.
- 3.1.2. Field Installation of Muffler Drain and Coolant Piping and Ductwork: As specified in Division 15 Sections "Basic Mechanical Materials and Methods," "Hydronic Piping," and "Metal Ductwork."
- 3.1.3. Maintain minimum workspace around components according to manufacturer's Shop Drawings and National Electrical Code.

#### **3.2. IDENTIFICATION:**

- 3.2.1. Identify system components according to Division 16 Section "Electrical Identification."

#### **3.3. FIELD QUALITY CONTROL:**

- 3.3.1. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise installation and connection of unit and to report results in writing.
- 3.3.2. Supervised Adjusting and Pretesting: Under supervision of factory-authorized service representative, pretest all system functions, operations, and protective features. Provide all instruments and equipment required for tests. Adjust to ensure operation is according to Specifications. Load system using a variable resistive and reactive load bank simulating kW, and power factor of loads for which unit is rated.

- 3.3.2.1. InterNational Electrical Testing Association Tests: Perform each visual and mechanical inspection and electrical and mechanical test stated in InterNational Electrical Testing Association's NETA ATS for emergency engine generator sets. Certify compliance with test parameters.
- 3.3.2.2. Battery Tests: Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery. Verify acceptance of charge for each element of battery after discharge. Verify measurements are within manufacturer's specifications.
- 3.3.2.3. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
- 3.3.2.4. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
- 3.3.2.5. Exhaust System Back-Pressure Test: Use a manometer with a scale exceeding 40 inches (1000 mm) of water. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
- 3.3.2.6. Exhaust Emissions Test: Conform to applicable government test criteria.
- 3.3.2.7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases and verify that performance is as specified.
- 3.3.2.8. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
- 3.3.3. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- 3.4. **CLEANING:**
- 3.4.1. Upon completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.
- 3.5. **DEMONSTRATION:**

- 3.5.1. Training: Engage a factory-authorized service representative to demonstrate adjustment, operation, and maintenance of system and to train Owner's maintenance personnel as specified below.
- 3.5.1.1. Conduct a minimum of 8 hours of training as specified in Division 1 Section "Contract Closeout."
- 3.5.1.2. Schedule training with at least 7 days' advance notice.
- 3.6. **COMMISSIONING:**
- 3.6.1. Battery Equalization: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.









ACTION CODE: A:30 DAYS AFTER NOTICE TO PROCEED

B: DURING CONSTRUCTION

[illegible]

# **SEYMOUR JOHNSON**

## **Air Force Base**

### **Goldsboro, North Carolina**

#### **SPECIFICATIONS**

#### **FOR**

**DATE:** 14 Oct 99

**PROJECT TITLE:** Repair "AFFF" Piping Buildings,  
4522, 4527, & 4538

**PROJECT NO:** VKAG 98-1123

**PROJECT MANAGER:** Matt Makdad



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\* Specification section added by 4 CES on 16 Feb 01

# **SECTION 01000 - GENERAL REQUIREMENTS**

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## **PART 1 - GENERAL**

### **1.1 SCOPE OF WORK**

- A. The work covered by this specification consists of furnishing all plant, labor, equipment and material, and performing all work in connection with the Repair AFFF Piping, 3 Hangars - VKAG-98-1123 Project in strict accordance with these specifications and drawings and subject to the terms and conditions of this contract. The contractor is to notify the A.H.J. (Authority Having Jurisdiction) prior to starting contract and prior to any acceptance testing.

### **1.2 LOCATION**

- A. The work is to be accomplished at Seymour Johnson Air Force Base, Goldsboro, North Carolina. This base is accessible by both public highway and railway.

### **1.3 WORK WEEK**

- A. The Contractor shall observe the following work week while performing work at Seymour Johnson AFB, which is 7:30 a.m. to 4:30 p.m., Monday through Friday with Federal holidays excluded. Any deviation from this schedule will require 48 hours advance notice and approval of the Contracting Officer or Authorized Representative.

### **1.4 PRINCIPLE FEATURES**

- A. The work covered by this contract includes:

- 1. **Mechanical Work:**

- Building's 4522, 4537, 4538

- a. Replace the schedule 10 cross main piping with new schedule 40 piping (in accordance with ASTM A-795) on the pre-action fire system throughout all bays due to multiple leaks in piping. Size piping as indicated on the drawings.
    - b. Use threaded, flanged, or grooved fittings. Do not use fittings which couple plain end pipe. Do not use welded sprinkler fittings or outlets for foam-water solution. Mark all exposed interior piping, at 8 meter (26 foot) intervals, with plastic wraparound-type pipe labels conforming to ASME/ANSI A13.1-1996, indicating the type of fluid carried and direction of flow.
    - \*c. Paint all exposed interior piping and conduits (Color to be the same as the adjacent walls/ceiling ).

## **2. Electrical Work:**

### **Building's 4522, 4537, 4538**

- a. Replace the pneumatic detectors in all bays with combination heat/rate of rise detectors.
- b. Replace all pull stations. New pull stations, which control the turret, shall have protective shields.
- c. Building 4537 only: Replace the three existing fire alarm control panels with one FACP, reusing the existing transmitter. New panel shall be modular type and surge protected.
- d. Upgrade fire alarm/detection system in accordance with NFPA standards.
- e. \*Provide electrical connections/support to complete the work for the installation of new piping and control switches.

## **1.5 DISPOSITION OF NON-SALVAGEABLE MATERIALS**

- A. All non-salvageable or unusable material shall be disposed of off base as directed by the Contracting Officer or Authorized Representative. All waste material generated by any work under this contract shall be handled, transported, stored and disposed of off base, by the Contractor, in accordance with all applicable federal, state, or local laws, ordinances, regulations, court orders, or other types of rules or rulings having the effect of law.

## **1.6 SUBMITTALS REQUIRED**

- A. Required submittals are listed on AF Form 66.

## **1.7 BASE CIVIL ENGINEERING WORK CLEARANCE REQUEST, AF FORM 103**

- \*A. The Contractor shall obtain AF Form 103, Base Civil Engineering Work Clearance Request, prior to commencement of work from the Contract Management Section in Bldg 3300, 1095 Peterson Avenue. Upon receipt of an AF Form 103, the Contractor shall be responsible for locating all base owned underground utilities, as well as, coordinating local utility companies to stake out utilities if not owned by the base. Historical drawings, as-built drawings, and topographic drawings are available for review at the 4<sup>th</sup> Civil Engineer Squadron, Design element located in Building 3300. Base owned utilities include but are not limited to electric, water, sewer, steam, communication, telephone, fiber optic, cathodic protection, and fuel lines. Utilities not owned by the base include but are not limited to cable TV, Southern Bell Telephone, and Natural Gas. The Contractor shall contact ULOCO and the non-base utility companies for location services. In the event that the Contractor damages a utility, which is commented in the plans, record drawings, or located by a utility locator; the Contractor shall repair/replace the utility at no additional cost to the Government. Utilities not documented, shown, or located by a locator shall be considered abandoned or unknown. Contractor damage to unknown or abandoned utilities shall be dealt with as a differing site condition.

## **1.8 SAFETY**

- A. All safety requirements of the U.S. Army Corps of Engineers Safety Manual 385-1 dated September 1996 will be strictly adhered to as related to all work covered under these specifications.

## **1.9 MATERIALS CONTAINING ASBESTOS**

- A. In the event the Contractor discovers materials suspected of containing asbestos that is not identified to be removed in the plans and specifications, the Contractor shall notify the Contracting Officer or Authorized Representative. The Contractor's work shall proceed unless the materials suspected of containing asbestos are damaged or disturbed. Any suspected materials damaged or disturbed by the Contractor without permission from the Contracting Office shall be removed by the Contractor at his expense IAW all applicable Federal, State, and local laws, ordinances, regulations, court orders, or other types of rules or rulings having the effect of law.

## **1.10 CONTRACTOR STORAGE TRAILER(S) AND BUILDING(S)**

- A. The Contractor shall place or paint a sign on all of his storage trailer(s) and building(s) used on this contract. At a minimum, the sign shall contain the name of the Contractor and a telephone number at which the Contractor can be reached. The trailer(s) and building(s) shall be complete with gates and/or doors which can be locked. Only material for this project shall be stored in the trailer(s) or building(s). The Contractor shall remove the storage trailer(s) or building(s) within 30 days after completion of the contract and prior to submitting his final invoice. The area around the storage trailer(s) and building(s) shall be kept clean. This includes the mowing of grass during the growing season. The lawn mower shall be supplied by the Contractor. A 1% retainage will be held from the contractor until assigned storage space has been cleaned and trailer/equipment removed from the site.

## **1.11 PHASING AND CONSTRAINTS**

- A. The following phasing shall apply;
1. \*The first 60 days is for submittal approval and material delivery. No on site work is to occur during this phase.
  2. The contractor shall have 220 days to complete the onsite work. In coordination with the Contracting Officer's Representative, the contractor shall be allowed access to only one (1) aircraft bay at a time and shall plan work accordingly. The contractor shall have on site all required materials and equipment to complete the work in a bay before commencing. All work in a bay shall be accepted by the contracting officer or authorized representative before proceeding to the next bay. Each bay shall be fully operational once accepted as complete.
  3. \*The contractor shall submit a schedule for approval on how the contractor intends to complete the work to minimize disruption to aircraft maintenance operations. Contractor shall anticipate a one to two day timeframe between completing a bay and receiving the next for work. The base reserves right to adjust work locations based on aircraft maintenance requirement.
- B. The following constraints shall apply;
1. \*The contractor shall only work in the bay and mechanical room that has

been cleared/scheduled for work.

2. \*The contractor shall not go into or perform work in any bay which contains an aircraft, without prior approval by contracting officer's representative.
3. The contractor will be required to cross an active taxiway. The contractor shall coordinate with the base operations on all required permits and driving instructions.
4. \*Contractor shall provide all knowledgeable personnel required to deactivate the alarm and sprinkler systems as required.
5. \*Contractor shall coordinate with contracting officer's representative, two weeks prior to start of work, for the preparation/coordination of temporary operations of fire protection in the entire building during alarm/suppression system outage.
6. \*In the event of hurricane warnings, the contractor shall remove all lift or other equipment from bays to allow base maximum room for aircraft protection. An appropriate time extension will be provided as needed.

#### **1.12 \*AFFIRMATIVE PROCUREMENT**

- \*A. The contractor shall incorporate Affirmative Procurement requirements per 40 CFR, Part 247 and Executive Order 13101: "Greening the Government Through Waste Prevention, Recycling and Federal Acquisition." Designated items used in the execution of this contract shall meet or exceed the Environmental Protection Agency's (EPA) requirements for recycled content materials (RCM) as per the EPA's Comprehensive Procurement Guidelines (CPG). The contractor shall ensure affirmative procurement requirements for CPG items are met or provide written justification that: 1) The price of a given designated item is unreasonably high, 2) There is inadequate competition (not enough sources of supply), 3) Unusual and unreasonable delays would result from obtaining the item, or 4) The item does not meet the Air Force's performance specifications.

#### **PART 2- PRODUCTS**

NOT USED

#### **PART 3- EXECUTION**

NOT USED

**END OF SECTION 01000**

## **SECTION 02070 - SELECTIVE DEMOLITION**

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### **PART 1 – GENERAL**

#### **1.1 DEFINITIONS**

- A. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain on SJAFB property.
- \*B. Remove and Salvage: Items indicated to be removed and salvaged remain the Government's property. Remove, clean, and pack or crate items to protect against damage. Identify contents of containers and deliver to contracting officer's designated storage area.
- C. Remove and Reinstall: Remove items indicated; clean, service, and otherwise prepare them for reuse; store and protect against damage. Reinstall items in the same locations or in locations indicated.
- D. Existing to Remain: Protect Construction indicated to remain against damage and soiling during selective demolition. When permitted by the Architect, items may be removed to a suitable, protected storage location during selective demolition and then cleaned and reinstalled in their original locations.

#### **1.2 MATERIALS OWNERSHIP**

- A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain on SJAFB property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option.

#### **1.3 SUBMITTALS**

- A. Schedule of selective demolition activities indicating the following:
  - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity.
  - 2. Interruption of utility services.
  - 3. Coordination for shutoff, capping, and continuation of utility services.
  - 4. Use of elevator and stairs.
  - 5. Detailed sequence of selective demolition and removal work to ensure uninterrupted progress of the on-site operations.
  - 6. Coordination of contracting officer's continuing occupancy of portions of existing building and of contracting officer's partial occupancy of completed Work.
  - 7. Locations of temporary partitions and means of egress.
- B. Inventory of items to be removed and salvaged.

- \*C. Inventory of items and equipment that will need to be relocated by the Government to allow contractor space to work.

## **1.4 PROJECT CONDITIONS**

- \*A. SJAFB will occupy portions of the building immediately adjacent to selective demolition area. Conduct selective demolition so that SJAFB's operations will not be disrupted. Schedule all activity with contracting officer or the authorized representative for the project. See section 01000.
- \*B. Not Used
  - \*1. Not Used
- C. Asbestos: It is not expected that asbestos will be encountered in the Work. If any materials suspected of containing asbestos are encountered, do not disturb the materials. Immediately notify the contracting officer or the authorized representative.
- \*D. Lead Based Paint (LBP): Existing paint on piping is assumed to be lead base paint. Contractor shall comply with all federal, state, and local regulations dealing with worker protection and the removal and disposal of lead base paint products.
- \*E. Storage or sale of removed items or materials on-site will not be permitted.

## **1.5 SCHEDULING**

- A. Arrange selective demolition schedule with the contracting officer or the authorized representative at Seymour Johnson Air Force Base.

## **1.6 WARRANTY**

- A. Existing Special Warranty: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

## **PART 2 - PRODUCTS (Not Applicable)**

### **2.1 REPAIR MATERIALS**

- A. Use repair materials identical to existing materials.
  - 1. Where identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
  - 2. Use materials whose installed performance equals or surpasses that of existing materials.

## **PART 3 – EXECUTION**

### **3.1 PREPARATION**

- A. Conduct demolition operations and remove debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
- B. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from contracting officer or the authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

### **3.2 SELECTIVE DEMOLITION**

- A. Demolish and remove existing Construction only to the extent required by new Construction and as indicated.

### **3.3 PATCHING AND REPAIRS**

- A. Promptly patch and repair holes and damaged surfaces caused to adjacent Construction by selective demolition operations.
- B. Restore exposed finishes of patched areas and extend finish restoration into adjoining Construction to remain in a manner that eliminates evidence of patching and refinishing.

### **3.4 DISPOSAL OF DEMOLISHED MATERIALS**

- A. General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
- B. Disposal: Transport demolished materials off SJAFB's property and legally dispose of them.

**END OF SECTION 02070**

## **PART 1 - GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- A. This Section includes surface preparation and field painting of exposed interior items and surfaces. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
  - 1. Paint exposed item or surface the same as similar adjacent materials.
  - 2. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
  - 3. Labels: Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

### **1.2 SUBMITTALS**

- A. For each paint system specified, provide the following:
  - 1. Material List: Provide an inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
  - 2. Manufacturer's Information: Provide manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.
  - 3. Proposed color samples intended to match adjacent surfaces.

### **1.3 QUALITY ASSURANCE**

- A. Source Limitations: Obtain primers and undercoat materials for each coating system from the same manufacturer as the finish coats.
- B. Deliver materials to the Project Site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label.
- C. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F (7 deg C). Maintain containers in clean condition, free of foreign materials and residue. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily.
- D. Project Conditions: Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Material Compatibility: Provide primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service

- and application, as demonstrated by manufacturer based on testing and field experience.
- B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified. Paint-material containers not displaying manufacturer's product identification will not be acceptable.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Examine substrates, areas, and conditions under which painting will be performed for compliance with paint application requirements. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
- B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates.
- C. Preparation: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
- D. Cleaning: Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease before cleaning. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- E. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition.
1. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with the Steel Structures Painting Council's (SSPC) recommendations.
    - a. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with the same primer as the shop coat.
  2. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.
- F. Materials Preparation: Mix and prepare paint materials according to manufacturer's written instructions. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
- G. Use only thinners approved by paint manufacturer and only within recommended limits.

#### **3.2.1 APPLICATION**

- A. Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
- B. Paint colors, surface treatments, and finishes are indicated in the schedules.
- C. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
- D. Provide finish coats that are compatible with primers used.
- E. The term "exposed surfaces" includes areas visible when permanent or built-in items are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
- F. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
- G. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
- H. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
- I. The number of coats and the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
- J. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
- K. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.
- L. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
- M. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.
- N. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.

- O. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

### **3.3 FIELD QUALITY CONTROL**

- A. The Government reserves the right to engage the services of an independent testing agency to sample the paint material being used. Samples of material delivered to the Project will be taken, identified, sealed, and certified in the presence of the Contractor.
- B. The testing agency will perform appropriate tests as required by the Government.
- C. If tests show material being used does not comply with specified requirements, the Contractor shall remove noncomplying paint from the site, pay for testing, and repaint surfaces previously coated with the rejected paint. If necessary, the Contractor may be required to remove rejected paint from previously painted surfaces if, on repainting with specified paint, the 2 coatings are incompatible.

### **3.4 CLEANING AND PROTECTION**

- A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site.
- B. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.
- C. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Contracting Officer or Authorized Representative.
- D. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.
- E. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

### **3.5 PAINT SCHEDULE**

- A. Ferrous Metal: Provide the following finish systems over ferrous metal:
  - 1. Low-Luster, Acrylic-Enamel Finish: Two finish coats over a primer.
    - a. Primer: Quick-drying, rust-inhibitive, alkyd-based or epoxy-metal primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils.
    - b. First and Second Coats: Low-luster (eggshell or satin), acrylic-latex, interior enamel applied at spreading rate recommended by manufacturer to achieve a total dry film thickness of not less than 2.8 mils.
- B. Zinc-Coated Metal: Provide the following finish systems over zinc-coated metal:
  - 2. Low-Luster, Acrylic-Enamel Finish: Two finish coats over a primer.

- a. Primer: Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.
- b. First and Second Coats: Low-luster (eggshell or satin), acrylic-latex, interior enamel applied at spreading rate recommended by manufacturer to achieve a total dry film thickness of not less than 2.8 mils.

**END OF SECTION 09900**

## ***SECTION 13915 - FIRE-SUPPRESSION PIPING***

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### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes upgrade to the fire-suppression piping for the following building systems:
  - 1. Pre-action System for Hangars: Building 4522, 4537, 4538 at Seymour Johnson Air Force Base.
    - a. Replace the schedule 10 cross main piping with new schedule 40 piping (in accordance with ASTM A-53 or ASTM A-795) on the pre-action fire system throughout all bays due to multiple leaks in piping. Size piping in accordance with NFPA and ETL 98-7.
    - b. Use threaded, flanged, or grooved fittings. Do not use fittings which couple plain end pipe. Do not use welded sprinkler fittings or outlets for foam-water solution. Mark all exposed interior piping, at 8 meter (26 foot) intervals, with plastic wraparound type pipe labels conforming to ASME/ANSI A13.1-1996, indicating the type of fluid carried and direction of flow.
    - \*c. Paint all exposed interior piping (Color to be the same as the walls/ceiling).
- B. Related Sections include the following:
  - 1. Division 16 Section "Fire Alarm Systems" for alarm devices not in this Section.

#### **1.3 SUBMITTALS**

- \*A. Product Data/Shop Drawings (All drawing for new piping shall be sealed by NC P.E.): For the following:

- 1. Pipe and fitting materials and methods of joining for sprinkler piping.
- 2. Pipe hangers and supports.

#### **1.4 QUALITY ASSURANCE**

- A. Installer Qualifications: An experienced installer who has designed and installed fire-suppression piping similar to that indicated for this Project and obtained design approval and inspection approval from authorities having jurisdiction.
- B. Manufacturer Qualifications: Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL's "Fire Protection Equipment

Directory" and FM's "Fire Protection Approval Guide" and that comply with other requirements indicated.

- C. NFPA Standards: Equipment, specialties, accessories, installation, and testing complying with the following:
  - 1. NFPA 13, "Installation of Sprinkler Systems."

## **PART 2 – PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Couplings for Steel Piping:
    - a. Grinnell Corp.
    - b. Victaulic Co. of America.
  - 2. Fire-Protection Service Valves:
    - a. Grinnell Corp.
    - b. Stockham
    - c. Crane

### **2.2 PIPING MATERIALS**

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

### **2.3 PIPES**

- A. Standard-Weight Steel Pipe: ASTM A 53, or ASTM A 795; Schedule 40, Black.

### **2.4 PIPE FITTINGS**

- A. Malleable-Iron Threaded Fittings: ASME B16.3.
- B. Steel, Threaded Couplings: ASTM A 865.
- C. Steel Flanges and Flanged Fittings: ASME B16.5.
- D. Steel, Grooved-End Fittings: UL-listed and FM-approved, **ASTM A 47** (**ASTM A 47M**), malleable iron or ASTM A 536, ductile iron; with dimensions matching steel pipe.

### **2.5 JOINING MATERIALS**

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for pipe-flange gasket materials.

## **PART 3 – EXECUTION**

### **3.1 PIPING APPLICATIONS**

- A. Do not use welded joints.
- B. Use threaded, flanged, or grooved fittings with pressure ratings the same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.

### **3.2 FIRE-PROTECTION SERVICE VALVES**

- A. General: UL listed and FM approved, with minimum 175 PSIG nonshock working pressure rating. Valves 2-1/2 inches and larger shall be flanged outside screw and yoke (0.5 & Y) type.
- B. Gate Valves, NPS 2-1/2 and Larger: UL 262, iron body, bronze mounted, taper wedge, 0.5 & Y, and rising stem.

### **3.3 JOINT CONSTRUCTION**

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
- B. Steel-Piping, Grooved Joints: Use Schedule 40 steel pipe with cut or roll-grooved ends. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions. Use gaskets listed for AFFF service for pre-action piping.

### **3.4 PIPING INSTALLATION**

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping installation.
- B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
  - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Contracting Officer before deviating from approved working plans.
- C. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.

- E. Install sprinkler piping with drains for complete system drainage.
- F. Install alarm devices in piping systems.
- G. Hangers and Supports: Comply with NFPA 13 for hanger materials. Install according to NFPA 13 for sprinkler piping.
- H. Earthquake Protection: Install piping couplings according to NFPA 13 to protect from earthquake damage.
- I. Install piping with grooved joints according to manufacturer's written instructions. Construct rigid piping joints, unless otherwise indicated.

### **3.4 CONNECTIONS**

- A. Electrical Connections: Power wiring is specified in Division 16.

### **3.5 LABELING AND IDENTIFICATION**

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14 and in Division 15 Section "Basic Mechanical Materials and Methods" and summary of work.

### **3.6 FIELD QUALITY CONTROL**

- A. Flush, test, and inspect sprinkler piping according to NFPA 13, "System Acceptance" Chapter.
- B. Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
- C. Report test results promptly and in writing to Contracting Officer and authorities having jurisdiction.

### **3.7 PROTECTION**

- A. Protect sprinklers from damage until Substantial Completion.

### **3.8 COMMISSIONING**

- A. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.
- B. Verify that specified tests of piping are complete.
- C. Verify with the Contracting Officer that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type, to match existing.
- D. Drain dry-pipe sprinkler piping.

- E. Pressurize and check dry-pipe sprinkler piping air-pressure maintenance devices and air compressors.
- G. Adjust operating controls and pressure settings.
- H. Coordinate with fire alarm tests. Operate as required.

### **3.9 DEMONSTRATION**

- A. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.
- B. Schedule demonstration with Contracting Officer with at least seven days' advance notice.

**END OF SECTION 13915**

# ***SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS***

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## **PART 1 – GENERAL**

### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

### **1.2 SUMMARY**

- A. This Section includes the following basic mechanical materials and methods to complement other Division 15 Sections.
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Installation requirements common to equipment specification sections.
  - 3. Mechanical demolition.
  - 4. Painting and finishing.
- B. Pipe and pipe fitting materials are specified in Division 15 piping system Sections.

### **1.3 DEFINITIONS**

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

### **1.4 SUBMITTALS**

- A. Product Data: For pipe fittings, and pipe markers.
- \*B. Not Used
- C. Samples: Of color, lettering style, and other graphic representation required for each identification material and device.

#### **1.4 QUALITY ASSURANCE**

- A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

#### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.

#### **1.7 SEQUENCING AND SCHEDULING**

- A. Coordinate mechanical equipment installation with other building components.
- B. Phasing of the mechanical and electrical installation shall be limited to performing work until completion in one (1) hangar bay at a time. Contractors shall not work in multiple hangar bays at a time.
- C. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work.
- D. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

### **PART 2- PRODUCTS**

#### **2.1 PIPE AND PIPE FITTINGS**

- A. Refer to individual Division 15 piping Sections for pipe and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

#### **2.2 JOINING MATERIALS**

- A. Refer to individual Division 15 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for AFFF foam.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

## **2.3 IDENTIFYING DEVICES AND LABELS**

- A. Wrap-Around Plastic Pipe Markers: Manufacturer's standard preprinted, semi-rigid, snap on, color-coded, complying with ASME A13.1, indicating the type of fluid carried and the direction of flow.
- B. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, lettering, and wording indicated for proper identification and operation/maintenance of mechanical systems and equipment.

## **PART 3 – EXECUTION**

### **3.1 PIPING SYSTEMS - COMMON REQUIREMENTS**

- A. General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 15 piping Sections specify unique piping installation requirements.
- B. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.
- C. Install piping at indicated slope.
- D. Install components with pressure rating equal to or greater than system operating pressure.
- E. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.
- F. Install piping free of sags and bends.
- G. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
- H. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
- I. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- J. Install fittings for changes in direction and branch connections.
- K. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping materials.
- L. Verify final equipment locations for roughing-in.
- M. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

- N. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections:
1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
  2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
  3. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    - a. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
    - b. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
    - c. Align threads at point of assembly.
    - d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
    - e. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
  4. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
- O. Piping Connections: Make connections according to the following, unless otherwise indicated:
1. Install flanges, in piping **2-1/2-inch NPS** and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
  2. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

### 3.2 LABELING AND IDENTIFYING

- A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
1. Plastic markers, with application systems.
  2. Locate pipe markers as follows if piping is exposed in finished spaces, machine rooms, and accessible maintenance spaces, such as shafts, tunnels, plenums, and exterior nonconcealed locations:
    - a. Near each valve and control device.
    - b. Near locations if pipes pass through walls, floors, ceilings, or enter nonaccessible enclosures.
    - c. At access doors, manholes, and similar access points that permit view of concealed piping.
    - d. Near major equipment items and other points of origination and termination.
    - e. Spaced at maximum of 26 feet (8meter) intervals along each run.

- f. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

### **3.3 PAINTING AND FINISHING**

- A. Pipe shall be cleaned of dirt and oil. Paint pipe to match existing sprinkler system.
- B. Apply two (2) coats of paint to piping according to the following, unless otherwise indicated:
  - 1. Interior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
  - 2. Interior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
- C. Do not paint piping specialties with factory-applied finish.
- D. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

### **3.4 DEMOLITION**

- A. Disconnect, demolish, and remove Work specified in Division 15 Sections.
- B. If pipe, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
- C. Accessible Work: Remove indicated exposed pipe in its entirety.
- D. Removal: Remove indicated equipment from Project site.
- E. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

**END OF SECTION 15050**

## ***SECTION 16050 – BASIC ELECTRICAL MATERIALS AND METHODS***

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### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

A. This Section includes the following:

1. Raceways.
2. Building wire and connectors.
3. Supporting devices for electrical components.
4. Electrical identification.
5. Electrical demolition.
6. Cutting and patching for electrical construction.
7. Touchup painting.

#### **1.3 DEFINITIONS**

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. RMC: Rigid metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. RGS: Rigid galvanized steel conduit.

#### **1.4 SUBMITTALS**

- A. Shop Drawing of As-Built all building required wiring color run, conduit.  
Labeling of alternates. Provide As-Built drawings of completed fire alarm systems.

#### **1.5 QUALITY ASSURANCE**

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- B. Comply with NFPA 70.

## **1.6 SEQUENCING AND SCHEDULING**

- A. Coordinate electrical equipment installation with other building components.
- B. Phasing of the mechanical and electrical installation shall be limited to performing work until completion in one (1) hangar bay at a time. Contractors shall not work in multiple hangar bays at a time.
- C. Sequence, coordinate, and integrate installations electrical materials and equipment for efficient flow of the Work.

## **PART 2 – PRODUCTS**

### **2.1 RACEWAYS**

- A. EMT: ANSI C80.3, zinc-coated steel, with set-screw or compression fittings.
- B. FMC: Zinc-coated steel.
- C. RMC: ANSI C80.5.
- D. LFMC: Zinc-coated steel with sunlight-resistant and mineral-oil-resistant plastic jacket.
- E. RGS: NEMA
- E. Raceway Fittings: Specifically designed for the raceway type with which used.

### **2.2 CONDUCTORS**

- A. Conductors, No. 10 AWG and Smaller: Solid or stranded copper.
- B. Conductors, Larger Than No. 10 AWG: Stranded copper.
- C. Insulation: Thermoplastic, rated at 75 deg C minimum.
- D. Wire Connectors and Splices: Units of size, ampacity rating, material, type, and class suitable for service indicated.

### **2.3 SUPPORTING DEVICES**

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
- C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch- (14-mm-) diameter slotted holes at a maximum of 2 inches (50 mm) o.c., in webs.
- D. Slotted-Steel Channel Supports:
  - 1. Channel Thickness: Selected to suit structural loading.

2. Fittings and Accessories: Products of the same manufacturer as channel supports.
- E. Nonmetallic Channel and Angle Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (203 mm) o.c., in at least one surface.
    1. Fittings and Accessories: Products of the same manufacturer as channels and angles.
    2. Fittings and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
  - F. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
  - G. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
  - H. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.
  - I. Expansion Anchors: Carbon-steel wedge or sleeve type.
  - J. Toggle Bolts: All-steel springhead type.
  - K. Powder-Driven Threaded Studs: Heat-treated steel.

## **2.4 ELECTRICAL IDENTIFICATION**

- A. Identification Devices: A single type of identification product for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape, not less than 1 inch wide by 3 mils thick (25 mm wide by 0.08 mm thick).
- C. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape with the following features:
  1. Not less than 6 inches wide by 4 mils thick (150 mm wide by 0.102 mm thick).
  2. Compounded for permanent direct-burial service.
  3. Embedded continuous metallic strip or core.
  4. Printed legend that indicates type of underground line.
  5. Consider alternatives before specifying product in paragraph below. See Editing Instruction No. 2 in the Evaluations.
- D. Tape Markers for Wire: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- E. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.
- F. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch (1.6-mm)

minimum thickness for signs up to 20 sq. in. (129 sq. cm) and 1/8-inch (3.2-mm) minimum thickness for larger sizes. Engraved legend in white letters on red background.

- G. Interior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Preprinted, aluminum, baked-enamel-finish signs, punched or drilled for mechanical fasteners, with colors, legend, and size appropriate to the application.
- H. Exterior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm), galvanized-steel backing, with colors, legend, and size appropriate to the application. 1/4-inch (6-mm) grommets in corners for mounting.
- I. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

## **2.5 TOUCHUP PAINT**

- A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.
- B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

## **PART 3 - EXECUTION**

### **3.1 ELECTRICAL EQUIPMENT INSTALLATION**

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Right of Way: Give to raceways and piping systems installed at a required slope.

### **3.2 RACEWAY**

- A. Use the following raceways for outdoor installations:
  - 1. Exposed: EMC.
  - 2. Concealed: EMC.
  - 3. Boxes and Enclosures: NEMA 250, Type 3R or Type 4.
- B. Use the following raceways for indoor installations:
  - 1. Exposed: EMT.
  - 2. Concealed: EMT.

3. Connection to Vibrating Equipment: FMC; except in wet or damp locations, use LFMC.
4. Damp or Wet Locations: EMC.
5. Boxes and Enclosures: NEMA 250, Type 1, unless otherwise indicated.

### **3.3 RACEWAY AND CABLE INSTALLATION**

- A. Conceal raceways and cables, unless otherwise indicated, within finished walls, ceilings, and floors.
- B. Install raceways and cables at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Locate horizontal raceway runs above water and steam piping.
- C. Use temporary raceway caps to prevent foreign matter from entering.
- D. Make conduit bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
- E. Use raceway and cable fittings compatible with raceways and cables and suitable for use and location.
- F. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of the pull wire.
- G. Install telephone and signal system raceways, 2-inch trade size (DN53) and smaller, in maximum lengths of 150 feet (45 m) and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements, in addition to requirements above.
- H. Connect motors and equipment subject to vibration, noise transmission, or movement with a maximum of 72-inch (1830-mm) flexible conduit. Install LFMC in wet or damp locations. Install separate ground conductor across flexible connections.

### **3.4 WIRING METHODS FOR POWER, LIGHTING, AND CONTROL CIRCUITS**

- A. Feeders: Type THHN/THWN insulated conductors in raceway.
- B. Branch Circuits: Type THHN/THWN insulated conductors in raceway.
- C. Branch Circuits: Type THW or THHN/THWN insulated conductors in raceway where exposed. Metal-clad cable where concealed in ceilings and gypsum board partitions.
- D. Branch Circuits: Type THW or THHN/THWN insulated conductors in raceway where exposed. Armored or nonmetallic sheathed cable where permitted by authorities having jurisdiction and where concealed in ceilings and gypsum board partitions.
- E. Remote-Control Signaling and Power-Limited Circuits: Type THHN/THWN insulated conductors in raceway for Classes 1, 2, and 3, unless otherwise indicated.

### **3.4 WIRING INSTALLATION**

- A. Install splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- B. Install wiring at outlets with at least 12 inches (300 mm) of slack conductor at each outlet.
- C. Connect outlet and component connections to wiring systems and to ground. Tighten electrical connectors and terminals, according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

### **3.6 ELECTRICAL SUPPORTING DEVICE APPLICATION**

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.
- B. Dry Locations: Steel materials.
- C. Support Clamps for PVC Raceways: Click-type clamp system.
- D. Selection of Supports: Comply with manufacturer's written instructions.
- E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb (90-kg) design load.

### **3.7 SUPPORT INSTALLATION**

- A. Install support devices to securely and permanently fasten and support electrical components.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- F. Install 1/4-inch- (6-mm-) diameter or larger threaded steel hanger rods, unless otherwise indicated.
- G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch (38-mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Simultaneously install vertical conductor supports with conductors.
- J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches (610 mm) from the box.
- K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
  - 1. Wood: Fasten with wood screws or screw-type nails.
  - 2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
  - 3. New Concrete: Concrete inserts with machine screws and bolts.
  - 4. Existing Concrete: Expansion bolts.
  - 5. Instead of expansion bolts, threaded studs driven by a powder charge and provided with lock washers may be used in existing concrete.
  - 6. Steel: Welded threaded studs or spring-tension clamps on steel.
    - a. Field Welding: Comply with AWS D1.1.
  - 7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
  - 8. Light Steel: Sheet-metal screws.
  - 9. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

### **3.8 IDENTIFICATION MATERIAL AND DEVICES**

- A. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout Project.
- C. Self-Adhesive Identification Products: Clean surfaces before applying.
- D. Identify raceways and cables with color banding as follows:
  - 1. Bands: Pretensioned, snap-around, colored plastic sleeves or colored adhesive marking tape. Make each color band 2 inches (51 mm) wide, completely

- encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
- 2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (8-m) maximum intervals in congested areas.
- 3. Colors: As follows:
  - a. Fire Alarm System: Red.
- E. Tag and label circuits designated to be extended in the future. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box. Color-coding may be used for voltage and phase identification.
- F. Color-code 208/120-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:
  - 1. Phase A: Black.
  - 2. Phase B: Red.
  - 3. Phase C: Blue.
  - 4. Neutral: White.
  - 5. Ground: Green.

### **3.9 FIRESTOPPING**

- A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly.

### **3.10 DEMOLITION**

- A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.
- C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches (50 mm) below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.
- D. Remove demolished material from Project site.
- E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

### **3.11 CUTTING AND PATCHING**

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been

disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

### **3.12 FIELD QUALITY CONTROL**

- A. Inspect installed components for damage and faulty work, including the following:
  - 1. Raceways.
  - 2. Building wire and connectors.
  - 3. Supporting devices for electrical components.
  - 4. Electrical identification.
  - 5. Electrical demolition.
  - 6. Cutting and patching for electrical construction.
  - 7. Touchup painting.

### **3.13 REFINISHING AND TOUCHUP PAINTING**

- A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "Painting."
  - 1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
  - 2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
  - 3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

### **3.14 CLEANING AND PROTECTION**

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

**END OF SECTION 16050**

# SECTION 16721 - FIRE DETECTION, ALARM AND RADIO TYPE REPORTING SYSTEM

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## PART 1 - GENERAL

### 1.1 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. All publications shall be referred to in their latest edition, including any revisions thereof.
1. American National Standards Institute (ANSI)
    - \*(a) ANSI C62.41 - Recommended Practice for Surge Voltage in Low-Voltage AC Power Circuits.
  2. National Fire Protection Association (NFPA)
    - \*(a) NFPA 70 - National Electrical Code
    - \*(b) NFPA 72 - National Fire Alarm Code
    - \*(c) NFPA 78 - Lighting Protection Code
    - \*(d) NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
  3. Underwriters Laboratories, Inc. (UL)
    - \*(a) UL Directory - Fire Protection Equipment Directory
    - \*(b) UL 06 - Rigid Metal Conduit
    - \*(c) UL 38 - Manually Actuated Signaling Boxes for Use with Fire-Protection Signaling Systems.
    - \*(d) UL 268 - Smoke Detectors for Fire Protective Signaling Systems.
    - \*(e) UL 268A - Smoke Detectors for Duct Application.
    - \*(f) UL 464 - Audible Signal Appliances.
    - \*(g) UL 521 - Heat Detectors for Fire Protective Signaling Systems.
    - \*(h) UL 797 - Electrical Metallic Tubing.
    - \*(i) UL 864 - Control Units for Fire Protective Signaling Systems.

## **1.2 GENERAL REQUIREMENTS**

- A. Products: The Contractor shall provide a fire alarm control panel as manufactured by Fire Control Instruments (FCI) or approved equal.
- B. Nameplates: Major components of equipment shall have the manufacturer's name, address type or style, voltage and current rating, and catalog number on a non-corrosive and non-heat sensitive plate which is securely attached to the equipment.
- C. Keys and Locks: Locks shall be keyed alike.
- D. Tags: Tags with stamped identification number shall be furnished for keys and locks on a key ring and given to the Contracting Officer.
- E. Verification of Dimensions: The contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.
- F. Compliance: The fire detection and internal alarm system shall be configured in accordance with NFPA 72. The equipment furnished shall be compatible and be UL listed or FM approved or approved or listed by a nationally recognized testing laboratory in accordance with the applicable NFPA standards.
- G. Manufacturer's Services: Services of a manufacturer's representative who is certified in the installation, maintenance, adjustment, operation and repair, of the equipment specified shall be provided. The representative shall supervise the installation, adjustment, programming, testing and certification of the equipment.
- H. Delivery and Storage: All equipment delivered and placed in storage shall be protected from the weather, humidity and temperature variations, dirt, dust and other contaminants.
- I. Programming: Contractor is required to fully program the transceiver and at the "Radio Alarm System" to communicate by zone and remote test.

## **1.3 SYSTEM DESIGN**

- A. Operation: System shall be a complete, supervised type fire alarm system. The system shall be activated into the alarm mode by actuation of any alarm initiating device. The system shall remain in the alarm mode until any initiating device is reset and the fire alarm control panel is manually reset and restored to normal. Electrical supervision shall be a class A system installed in accordance with NFPA 72. All circuits shall be capable of operating under a single ground or open condition, as specified in NFPA 72. All textual, audible and visual devices and systems shall comply with NFPA 72.
- B. Operational Features. The system shall have the following operating features:
  - 1. See drawings for # of Class A (Style B) alarm initiating (zone) circuits for connection of detection devices such as four-wire automatic detectors and manual pull stations.
  - 2. Four Class A (Style Y) indicating (bell) circuits for connection of audible and visual alarm evacuation signaling devices; each circuit may be programmed as silenceable or non-silenceable.

- \*3. Not used.
- \*4. An auxiliary alarm output which is used in conjunction with zones that are programmed for water-flow alarm, foam activation alarm, or positive alarm sequence.
- 5. An auxiliary power output which provides one amp, 24 volt, dc power.
- 6. One Form C (24 vdc) auxiliary relay programmable to operate with one (1) or more zones.
- \*7. Not used.
- \*8. Not used.
- 9. Switches for silencing and the audible alert, acknowledging alarms and trouble conditions, normalizing the panel, restarting the transmitter, testing LED operation and performing drill tests.
- \*10. Walk test and individual zones may be disabled at the panel.
- \*11. Not used.
- \*12. AC power failures, tamper input activations and battery faults are specifically reported to the central fire alarm control panel with the specific address. A battery fault report indicates a disconnected battery, or high or low battery charging voltage; the specific condition is displayed. Low battery shut down circuitry prevents complete battery discharge.
- 13. Automatic battery backup for 60 hours of standard operation in the event of an AC power failure.
- \*14. A trouble alarm silence switch shall be provided which will silence the trouble buzzer, but will not extinguish the trouble indicator lamp. After the system returns to normal operating conditions, the trouble buzzer shall again sound until the silencing switch returns to normal position, unless automatic trouble reset is provided.
- \*15. Not used.
- \*16. An alarm condition on a circuit shall automatically deactivate the air handling and air make-up units throughout the building with N.C. contacts.
- 17. Trouble buzzer and trouble lamp (light emitting diode or neon light-to activate upon single break; open, or ground fault condition which prevents the required normal operation of the system. The trouble signal shall also operate upon loss of primary power (AC) supply, low battery voltage, removal of alarm zone modules, and disconnection of the circuit used for transmitting alarm signals off premises.
- 18. Electrical supervision of the primary power (AC) supply, battery voltage, placement of alarm zone modules within the control panel, and transmitter tripping circuit integrity.
- 19. Transmitter disconnect switch to allow testing and maintenance of the system without activating the transmitter.

20. Evacuation alarm silencing switch or switches which, when activated, will silence alarm devices, but will not affect the zone indicating lamp no the operation of the transmitter. This switch shall be overridden upon activation of a subsequent alarm from an unalarmed zone and the alarm devices will be activated.
21. Electrical supervision of circuits used for supervisory signal services. Supervision shall detect all opens, shorts and grounds.
22. Zones for alarm initiating circuits shall be arranged as indicated on the contract drawings.
23. Alarm functions. An alarm condition on a circuit shall automatically initiate the following functions:
  - (a) Transmission of a signal (by zone and general alarm/general trouble) over the station fire reporting system.
  - (b) Visual indication of the alarmed zone on the fire alarm control panel annunciator located at a remote location other than with the control panel.
  - (c) Continuous sounding of alarm indicating devices throughout the building.
  - (d) Deactivation of the air handling units throughout the building.
  - (e) \*Activation of foam indicating strobe as required with the activation of the foam system.
24. Primary Power: Operating power shall be single phase taken from the building electric services as specific. Circuit breaker shall be provided with key lock. Transfer from normal to emergency (battery) power or restoration from emergency (battery) to normal power shall be fully automatic and not cause transmission of a false alarm. Loss of ac power shall not prevent transmission of a signal via the fire reporting system upon operation of any initiating circuit. Circuit disconnecting means shall be clearly marked "Fire Alarm Circuit".

#### **1.4 SUBMITTALS**

- A. Installer Qualification. Installer must have five (5) years experience in the installation of fire alarm systems and possess a minimum LEVEL II certificate from the NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET) in the sub-field FIRE PROTECTION ENGINEERING TECHNOLOGY (FIRE ALARM SYSTEMS).
- B. Shop Drawings. Shop drawings shall be submitted and shall consist of three (3) complete sets of equipment and materials, including manufacturer's descriptive and technical literature; performance charts and curves; catalog cuts; and installation instructions. Detail drawings shall also contain complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation.

- C. Test Reports. Upon completion and testing of the installed system, test reports shall be submitted in booklet form showing all field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls.
- D. Operation and Maintenance Manuals.
  - 1. The contractor shall furnish the Contracting Officer three (3) complete copies of operating instructions outlining step-by-step procedures required for system start up, operation and shut down. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features.
  - 2. The contractor shall furnish the Contracting Officer three (3) copies of maintenance instructions listing routing maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The instructions shall include conduit layout and simplified wiring, and control diagrams of the system installed.
- E. \*Spare Parts Data. After approval of the shop drawings the contractor shall furnish spare parts data for each different item of materials and equipment specified. The data shall include a complete list of parts and supplied, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 3 years of service.
- F. \*As Built Drawings. PRIOR TO PERFORMANCE AND ACCEPTANCE TESTING. The contractor shall submit three (3) legible copies of all fire alarm drawings showing the "as-built" system. The detail drawings of the fire detection system shall be signed by a Fire Protection Engineer. The drawings shall consist of a complete list of equipment and material, including manufacturer's descriptive and technical literature and catalog cuts. The drawings shall also contain complete wiring and schematic diagrams for the equipment furnished, equipment layout, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. The detailed point-to-point wiring diagram showing all points of connection shall include connections between system devices, appliances, control panels, supervised devices, and all equipment that is activated by the control panel.
- F. Certificates of Completion. PRIOR TO PERFORMANCE AND ACCEPTANCE TESTING, A Certificate of Completion per NFPA 72 shall be given to the Contracting Officer. "NOTE" The individual signing the certificate is warranting that the fire alarm system has been installed per NFP, NEC, UL and Air Force specifications and codes.
  - 1. Training. The certified fire alarm contractor shall provide a minimum of eight (8) hours training to the Fire Department and Fire Alarm Maintenance personnel on each system. Provide two (2) weeks advance notice to the Contracting Officer.

## **1.5 OVER VOLTAGE AND SURGE PROTECTION**

- A. \*Power Line Surge Protection. Reuse/reconnect existing surge protectors for new fire alarm equipment.

## **1.6 DELIVERY AND STORAGE**

- A. All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust, any other contaminants.

## **PART 2 - PRODUCTS**

### **2.1 CONTROL UNIT**

- A. The control unit provided shall be an FCI Model FC-72-# (Number of zones, as indicated on the drawings). The control unit shall be U.L. Listed for an unlimited number of initiating and notification appliance circuits.

### **2.2 SYSTEM CABINET**

- A. The system cabinet shall be constructed of 16-gauge cold rolled (CR) steel, and have a hinged door. The door shall contain a single lock, keyed alike with the manual stations provided.
- B. Reset switches, silence switches, fuses, etc. shall be clearly marked and shall be behind the locked door to prevent unauthorized entry. Opening of the main door shall expose all components for inspection and/or adjustment without any further dismantling of the system.

### **2.3 MOUNTING**

- A. The system cabinet shall be surface mounted, with a red textured finish.

### **2.4 AUDIBLE SYSTEM TROUBLE SOUNDER**

- A. Provisions shall be provided for an optional supervised remote trouble signal.

### **2.5 POWER SUPPLY AND CHARGER**

- A. The 120 VAC main power shall be transformer converted to low voltage, rectified and regulated 24 VDC for system operation, to eliminate the possibility of line voltage being present on any internal panel components.
- B. \*The entire system shall operate on 24 VDC, filtered and regulated, with the rated current available from one (1) power supply being 4 amperes. Depending upon system size, it shall be possible to increase project specific power supply capabilities by adding one or more auxiliary power supplies.
- C. The power supply shall comply with U.L. Standard 864 for power limited and "brown out" operation".
- D. Power supply capabilities provided shall be sufficient enough to provide power for the complete system including auxiliary devices and stand-by battery charging.
  - 1. Primary Power LED Indicator and Outputs. A green "Power On" LED located on the power supply shall be provided to indicate the presence of primary power. Power supply output shall be 4 amperes.
- E. BATTERY CHARGER
  - 1. The power supply shall contain an integral battery charger with a maximum charging current of 0.9 ampere (this current shall be sufficient to maintain the system batteries at full charge).
  - 2. If the system loses AC power, the system trouble sounder shall sound.

3. The charger output shall be fused and supervised through the basic master fire card.
4. The charger shall be capable of maintaining either sealed lead-acid or vented nickel-cadmium batteries.

**F. OPTIONAL DUAL RATE BATTERY CHARGER (DRBC)**

1. An optional dual rate battery charger (DRBC) shall be provided containing "HIGH RATE", "TROUBLE", and "AC" LED indicators, as well as a voltmeter and millimeter to measure the charging current and voltage. There shall be a "Low/No Battery" trouble indicator that shall also operate the general trouble devices as specified herein but shall not cause an alarm to be sounded.
2. The charger shall be capable of maintaining either sealed lead-acid or vented nickel-cadmium batteries.

**G. BATTERIES**

1. Batteries shall be of sufficient capacity to provide power for the entire system upon loss of normal 120 VAC power for a period of sixty (60) hours with five (5) minutes of alarm signaling at the end of this sixty (60) hour period, as required by NFPA 72 (Auxiliary or Remote Station system.)

**H. CONNECTIONS AND CIRCUITS**

- \*1. Connections to the light and power service shall be on a dedicated branch circuit in accordance with the National Electrical Code (NEC).
2. The circuit and connections shall be mechanically protected.
3. A circuit disconnecting means shall be accessible only to authorized personnel and shall be clearly marked "FIRE ALARM CIRCUIT CONTROL".

**2.6 BASIC MASTER FIRE CARD (BMFC)**

- A. Enclosed within the system cabinet, the BMFC shall provide all of the system signaling and supervisory functions of the FC-72 series fire alarm control. It is the nucleus of the system that serves as the interface between all external devices and the operating circuits.

**2.7 MINIMUM SYSTEM CONFIGURATION**

- A. The BMFC shall be comprised of a minimum of one (1) or two (2) supervised initiating circuits, and two (2) supervised notification appliance circuits. Initiating and notification appliance circuits shall be expandable to practically any requirement utilizing FC-72 series expansion modules.

**2.8 VISUAL INDICATORS AND SWITCHES**

- A. The BMFC shall have five (5) visual trouble indicators and five (5) functional switches as listed below:
  1. LEDs:
  2. GROUND FAULT
  3. GROUND FAULT (positive)
  4. GROUND FAULT (negative)
  5. SHORT CIRCUIT FAULT

\*6. Not used.

**B. SWITCHES:**

1. TROUBLE SILENCE
2. BATTERY/BELL TEST
3. LAMP TEST
4. RESET
- \*5. TRANSMITTER DISCONNECT

**2.9 MATRIX FEATURE**

- A. A unique system programming matrix configuration shall be provided on the BMFC to allow system installations to be field programmed for a wide variety of special applications, for example: Pre-signal-signal operation, Agent Release capabilities, Signaling by Zone and separate zone output matrixes. Systems that require module to module wiring to support these features shall not be accepted.

**2.10 TROUBLE DRY CONTACT**

- A. A system trouble dry SPDT contact shall be provided, rated at 2 amps at 24 VDC (resistive) and shall transfer whenever a system trouble occurs.

**2.11 ALARM DRY CONTACT**

- A. A system alarm dry SPDT contact shall be provided, rated at 2 amps at 24 VDC (resistive) and shall transfer whenever a system alarm occurs.

**2.12 NOTIFICATION APPLIANCE CIRCUITS**

- \*A. One (1) or more independent notification appliance circuits shall be provided, as per the plans and specification requirements. Each circuit shall be rated at 1.75 amps, along with being individually fused @ 2 amps, and supervised for opens, grounds, and short circuits. Style Z (Class "A") wiring shall be available. Systems that require additional modules to support this feature shall not be accepted.

**2.13 ZONE DETECTION MODULE (ZDM)**

- \*A. Zone Detection Modules (ZDM) shall be provided in accordance with the number of initiating detection circuits required by the plans and specifications. Each ZDM shall be capable of being wired as a Style D (Class "A") circuit. Each ZDM shall incorporate a supervised remote annunciator output, capable of driving an LED or incandescent lamp, and a set of Form "C" dry alarm contacts. Supervised alarm and trouble LEDs shall be an integral part of each ZDM. The ZDMs provided shall incorporate independent signal silence switches, with "subsequent alarm" feature. Each ZDM shall be capable of coded or non-coded operation, and may be field programmable for waterflow detection, and supervisory device monitoring.

**2.14 RELEASING DEVICE MODULE (RDF)**

- \*A. A releasing device module, (RDF) shall be capable of operating UL Listed solenoid valves and Approved by Factory Mutual Research for actuation of any solenoid valves listed in Factory Mutual Research Groups [A] and [B].

**2.15 PERIPHERAL DEVICES**

**\*A. Manual Station for House Alarm:**

- \*1.** Furnish and install a manual station, at each location indicated on the drawings. Each manual station shall be of the non-coded double action type. Upon the pulling forward of the actuator door, the unit shall lock into a readily observable "alarm" position. The manual station shall be constructed of aluminum. Each manual station shall require a key to reset the actuated station, this key shall be the same as the key which opens the fire alarm control panel. The manual stations shall employ a highly reliable action to activate an alarm, this feature shall provide an exceptionally high resistance to accidental operation.

**\*B. Manual Station for Foam Activation:**

- \*1.** Furnish and install a manual station, at each location indicated on the drawings. Each manual station shall be of the non-coded double action type, requiring a clear outer door to be lifted to expose the actuator. Upon the pulling forward of the actuator door, the unit shall lock into a readily observable "alarm" position. The manual station shall be constructed of aluminum. Each manual station shall require a key to reset the actuated station, this key shall be the same as the key which opens the fire alarm control panel. The manual stations shall employ a highly reliable action to activate an alarm, this feature shall provide an exceptionally high resistance to accidental operation.

## **2.16 AUTOMATIC INITIATING DEVICES**

### **\*A. Combination Rate of Rise/Heat Detectors**

- \*1. Detectors shall be outlet box mounted and supported independently of wiring connections. Contacts shall be self-resetting after response to rate-of-rise principle. Under actuation, the detector shall have a LED indication which is readily visible. Detectors located in areas subject to moisture or exterior atmospheric conditions or hazardous locations as defined by NFPA 70, shall be types approved for such locations. Detectors shall have screw terminals for making all wiring connections. Detectors shall be of the low profile type. Power shall be supervised and detectors shall incorporate relays as necessary for supervision. Rating for fixed temperature portion shall be 200 degrees F.

### **\*B. Smoke Detectors.**

- \*1. Detectors shall be designed for detection of abnormal smoke densities by the ionization principle. Detectors shall contain a visible indicator lamp that shows when the unit is in alarm condition. Detectors shall not be adversely affected by vibration or pressure. Detectors shall be the plug-in type in which the detector base contains terminals for making all wiring connections. Detectors that are in concealed locations shall be provided with a remote visible indicator lamp. Power shall be supervised and detectors shall incorporate relays as necessary for supervision.
- \*2. Duct Smoke Detectors. Detectors shall have a duct housing, mounted exterior to the duct, with perforated sampling tubes. Activation of a detector shall cause shutdown of the associated air-handling unit through a set of normally closed contacts. Detectors shall be rated for the air velocity to be expected. Detectors shall be mounted in readily accessible locations. Detectors shall be capable of activating a remote indicating lamp on a remote annunciator.

## **2.17 GRAPHIC ANNUNCIATOR**

- A. Furnish and install a remote zone graphic annunciator. The annunciator shall be capable of being flush or surface mounted for indoor or outdoor applications. One zone of annunciation shall be for system trouble. The unit shall be capable of having a remote key reset feature. Furnish FCI Model RZA-GA# in a black textured enclosure. Removal of the front cover shall provide easy access to replace lamps/LEDs. The number of zones shall be as shown on the drawings. All alarm lamps/LEDs and wiring shall be supervised.

## **2.18 FIRE DETECTION AND ALARM SYSTEM PERIPHERAL EQUIPMENT**

- A. Conduit shall comply with UL 06 and UL 797.
- B. Wiring. All wiring shall be copper. Wiring for 120 v AC power shall be No. 12 AWG minimum. Wiring for power limited circuits shall be No. 14 AWG minimum. Power wiring and control wiring shall be isolated. All wiring shall conform to NFPA 70. All conductors shall be color coded. Wiring code color shall remain uniform throughout the circuit. Pigtail or T-tap connections are unacceptable.
- C. Special Tools and Spare Parts. Special tools necessary for the maintenance of the equipment shall be furnished. Two (2) spare sets of fuses of each type and size required and five (5) spare lamps and LEDs of each type shall be furnished.

Two (2) percent of the total number of each detector, but no less than two (2) each, shall be furnished.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. All work shall be installed as shown and in accordance with the manufacturer's diagrams and recommendations, unless otherwise specified.
- B. Power Supply for System. A single dedicated branch-circuit connection for supplying power to each building system shall be provided. Emergency power supply shall be automatically transferred upon failure of the normal power supply. The power disconnect shall be separate from the circuit breaker. The disconnect shall be the type that can be locked in the "on" position and painted red.
- C. Wiring. Wiring for systems shall be installed in 1/2 inch minimum diameter conduit; however, the wiring for the fire alarm system shall not be installed in conduits, or junction boxes with conductors of lighting and power systems. No more than one (1) conductor shall be installed under any screw terminal. All circuits conductors entered or leaving any mounting box, outlet box enclosure or cabinet shall be connected to terminals with each terminal marked in accordance with the wiring diagram for identification. Connections shall be made with either crimp-on terminal spade lugs or with approved pressure type terminal blocks. The use of wire nut type connectors are prohibited in the system. All wiring within any control equipment shall be readily accessible without removing any component parts. The fire alarm equipment manufacturer's representative shall be present for the connection of wiring to the control panel.
- D. Control Panel. The control panel and its assorted components shall be mounted so that no part of the enclosing cabinet is less than 12 inches above the finished floor nor more than 78 inches above the finished floor. All manually operable controls shall be at least 3 feet and less than 5 feet above the finished floor. Panel shall be installed to comply with the requirements of UL 864. Unless otherwise indicated panel shall be installed on a 3/4 inch thick plywood backboard. Backboard shall be finished with two (2) coats of varnish. Space shall be reserved on backboard for future devices.
- E. Detectors. Detectors shall be installed in accordance with NFPA 72. Detectors shall be at least 12 inches from any part of lighting fixtures. Detectors shall be located at least 3 feet from diffusers of air handling systems. Each detector shall be provided with appropriate mounting hardware as required by its mounting location. Detectors which mount in free space shall be mounted directly to the end of the stubbed down rigid conduit drop. Conduit drops shall be firmly secured to minimize detector sway. Where length of conduit drop from ceiling or wall surface exceeds 3 feet, sway bracing shall be provided.
- F. Painting. All junction boxes shall be painted red.
- G. Notification Appliances. Devices shall be mounted a minimum of 8 feet above the finished floor unless limited by ceiling height or otherwise indicated.
- H. Grounding. Bonding shall be provided to building ground.

### **3.2 TESTING**

- \*A. The contractor shall notify the Contracting Officer or Contracting Officer's Representative 30 days before the performance and acceptance tests are to be conducted. The Contractor shall provide battery calculations for the fire alarm system to the Contracting Officer or Contracting Officer's Representative 30 days prior to the acceptance test. The test shall be performed in the presence of the Contracting Officer or Contracting Officer's Representative under the supervision of the fire alarm system manufacturer's qualified representative. The contractor shall furnish all instruments, equipment and personnel required for the tests.
- B. Preliminary Tests. Upon completion of the installation, the system shall be subjected to functional and operational performance tests including tests of each installed initiating and notification appliance. Tests shall include the meggering of all system conductors to determine that the system is free from grounded, shorted and open circuits. The megger test shall be conducted prior to the installation of fire alarm equipment. Smoke detector bases shall be equipped with jumpers for the megger test. If deficiencies are found, corrections shall be made and the system shall be retested to assure that is functional.
- C. Acceptance Test. The testing shall be in accordance with NFPA 72 and shall verify that all previous deficiencies have been corrected. The test shall include the following:
  - 1. Test of each function of the control panel.
  - 2. Test of each circuit in both trouble and normal modes.
  - 3. Test of alarm initiating devices in both normal and trouble conditions.
  - 4. Test of each control circuit and device.
  - 5. Test of each alarm notification appliance.
  - 6. Test of the battery charger and batteries.
  - 7. Complete operational test under emergency power supply.
  - 8. Visual inspection of all wiring connections.
  - 9. Opening the circuit at each alarm initiating and indicating device to test the wiring supervisory feature.
  - 10. Test of the as-built drawings to insure that they are correct.

**END OF SECTION 16721**

SCHEDULE OF MATERIAL SUBMITTALS												PROJECT NUMBER VKAG 98-1123	PROJECT TITLE REPAIR "AFF" PIPING BUILDINGS, 4522, 4537 & 4538		SOLICITATION / CONTRACT NUMBER						
TO BE COMPLETED BY PROJECT ENGINEER												TO BE COMPLETED BY CONTRACT ADMINISTRATION									
LINE NUMBER	ITEM OR DESCRIPTION OF ITEM CONTRACT REFERENCE, TYPE OF SUBMITTAL	NUMBER OF COPIES REQUIRED										REQUIRED SUBMISSION DATE	DATE RECEIVED IN CONTRACTING	DATE TO CIVIL ENGINEERING	RETURN SUSPENSE DAT	SUBMITTAL NUMBERS	DATE CONTR NOTIFIED		CONTRACTOR RESUBMITTAL	FINAL APPROVAL	REMARKS
		CERTIFICATION OF COMPLIANCE	SHOP DRAWINGS	SAMPLES	COLOR SELECTION	MANUFACTURER'S RECOMMENDATIONS	MANUFACTURER'S WARRANTY	PRODUCT DATA	OPERATING INSTRUCTIONS	TEST REPORTS	OTHER						APPROVED	DIS- APPROVED			
1	02070-1 1.3 A.1.-A.7. SELECTIVE DEMOLITION										3	A									
2	02070-2 1.3 B. SELECTIVE DEMOLITION										3	A									
3	02070-2 1.3 C. SELECTIVE DEMOLITION										3	A									
4	13915-1 1.3 A. FIRE SUPPRESSION PIPING							3				A									
5	15050-1 1.4 A. BASIC MECHANICAL MATERIALS AND METHODS							3				A									
6	15050-2 1.4 C. BASIC MECHANICAL MATERIALS AND METHODS			3								A									
7	16050-1 1.4 A. BASIC ELECTRICAL MATERIALS AND METHODS		3									A									
8	16721-5 1.4 A. DETECTION, ALARM AND RADIO TYPE REPORTING SYSTEM									3		A									
9	16721-5 1.4 B. DETECTION, ALARM AND RADIO TYPE REPORTING SYSTEM		3									A									
10	16721-5 1.4 C. DETECTION, ALARM AND RADIO TYPE REPORTING SYSTEM								3			B									
11	16721-5 1.4 D.1.-D.2. DETECTION, ALARM AND RADIO TYPE REPORTING SYSTEM							3				B									
12	16721-6 1.4 E. DETECTION, ALARM AND RADIO TYPE REPORTING SYSTEM									3		B									
13	16721-6 1.4 F. DETECTION, ALARM AND RADIO TYPE REPORTING SYSTEM	3										B									
14																					

# **SEYMOUR JOHNSON**

## **Air Force Base**

### **Goldsboro, North Carolina**

#### **SPECIFICATIONS**

**FOR**

**DATE:** JUNE 4, 2001

**PROJECT TITLE:** REPAIR FIRE SUPPRESSION,  
BLDG. 5015

**PROJECT NO:** VKAG 98-1124

**PROJECT MANAGER:** LT SHANNON EASTERLING



## **SPECIFICATIONS**

**DIVISION 1      GENERAL**  
01000      GENERAL

**DIVISION 2      SITE WORK**  
02070      SELECTIVE DEMOLITION  
02300      EARTHWORK  
02510      WATER DISTRIBUTION  
02511      HOT MIX ASPHALT PAVING  
02920      LAWNS & GRASSES

**DIVISION 3      CONCRETE**  
03300      CAST-IN-PLACE CONCRETE

**DIVISION 7      THERMAL AND MOISTURE PROTECTION**  
07841      THROUGH-PENETRATION FIRE STOP SYSTEMS

**DIVISION 9      FINISHES**  
09900      PAINTING

**DIVISION 13      SPECIAL CONSTRUCTION**  
13916      FIRE-SUPPRESSION SPRINKLERS  
13921      ELECTRIC-DRIVE, HORIZONTAL FIRE PUMPS, VERTICALLY MOUNTED

**DIVISION 16      ELECTRICAL**  
16060      GROUNDING AND BONDING  
16120      CONDUCTORS AND CABLES  
16130      RACEWAYS AND BOXES  
16721      FIRE DETECTION, ALARM, AND RADIO TYPE REPORTING SYSTEM

## SECTION 01000

### GENERAL

- 1.1 SCOPE OF WORK: The work covered by this specification consists of furnishing all plant, labor, equipment and material, and performing all work in connection with VKAG 98-1124, REPAIR FIRE SUPPRESSION SYSTEM, BUILDING 5015 in strict accordance with these specifications and drawings and subject to the terms and conditions of this contract.
- 1.2 LOCATION: The work is to be accomplished at Seymour Johnson Air Force Base, Goldsboro, North Carolina. This base is accessible by both public highway and railway.
- 1.3 WORKWEEK: The contractor shall observe the same regular workweek being observed by the Seymour Johnson AFB Civil Engineering shop forces, which is 7:30 a.m. to 4:30 p.m., Monday through Friday, with Federal holidays excluded. Any deviation from this schedule will require 48 hours advance notice and approval of the Contracting Officer.
- 1.4 PRINCIPLE FEATURES: The work covered by this contract includes, but is not limited to the following:
- A. Fire Suppression Sprinklers, Fire Alarm System, and Fire Pump.
- 1.5 HAUL ROUTES: The Contractor shall use the haul routes indicated on the plans.
- 1.6 DISPOSITION OF NONSALVAGEABLE MATERIALS: All nonsalvageable or unusable material shall be disposed of off base as directed by the Contracting Officer. All waste material generated by any work under this contract shall be handled, transported, stored, and disposed of off base, by the Contractor, in accordance with all applicable federal, state, or local laws, ordinances, regulations, court orders, or other types of rules or rulings having the effect of law.
- 1.7 DISPOSITION OF SALVAGEABLE MATERIALS: The Contractor shall be required to furnish an itemized listing of materials to be salvaged to the Base Civil Engineering material Control section, located in Bldg 3300, so that an AF Form 1348-1 can be obtained. After receiving this form, all salvable or reusable material will be delivered to the Defense reutilization and Marketing Office, which is located near Bldg 2620 or as directed by Contracting Officer.
- 1.8 SUBMITTALS REQUIRED: Required submittals are listed on AF Form 66.
- 1.9 BASE CIVIL ENGINEERING WORK CLEARANCE REQUEST, AF FORM 103: The Contractor shall obtain AF Form 103, Base Civil Engineering Work Clearance Request, prior to work commencement from the Contract Management Section in Bldg 3300, 1095 Peterson Avenue. Upon receipt of an AF Form 103, the Contractor shall be responsible for locating all base owned underground utilities, as well as, coordinating local utility companies to stake out utilities if not owned by the base. Historical drawings, as-built drawings, and topographic drawings are available for review at the 4<sup>th</sup> Civil Engineer Squadron, Design element located in Building 3300. Base owned

utilities include but are not limited to electric, water, sewer, steam, communication, telephone, fiber optic, cathodic protection, and fuel lines. Utilities not owned by the base include but are not limited to cable TV, Southern Bell Telephone, and Natural Gas. The Contractor shall contact ULOCO and the non-base utility companies for location services. In the event that the Contractor damages a utility which is commented in the plans, record drawings, or located by a utility locator, the Contractor shall repair/replace the utility at no additional cost to the Government. Utilities not documented, shown, or located by a locator shall be considered abandoned or unknown. Contractor damage to unknown or abandoned utilities shall be dealt with as a differing site condition.

- 1.10 **SAFETY:** All safety requirements of the U.S. Army Corps of Engineers Safety Manual 385-1-1 dated October 1996 will be strictly adhered to as related to all work covered under these specifications.
- 1.11 **MATERIALS CONTAINING ASBESTOS:** In the event the Contractor discovers materials suspected of containing asbestos that is not identified to be removed in the plans and specifications, the Contractor shall notify the Contracting Officer. The Contractor's work shall proceed unless the materials suspected of containing asbestos are damaged or disturbed. Any suspected materials damaged or disturbed by the Contractor without permission from the Contracting Officer shall be removed by the Contractor at his expense IAW all applicable Federal, State, and local laws, ordinances, regulations, court orders, or other types of rules or rulings having the effect of law.
- 1.12 **MATERIALS CONTAINING LEAD:** In the event the Contractor discovers materials suspected of containing lead that is not identified to be removed in the plans and specifications, the contractor shall notify the Contracting Officer. The Contractor's work shall proceed unless the materials suspected of containing lead are damaged or disturbed. Any suspected materials damaged or disturbed by the Contractor without permission from the Contracting Officer shall be removed by the Contractor at his expense in accordance with all applicable Federal, State, and local laws, ordinances, regulations, court orders, or other types of rules or rulings having the effect of law. Known items that contain lead in project VKAG 98-1124 are lead paint on sprinkler system piping. Lead content  $0.90 \text{ mg/cm}^2$  and  $0.56 \text{ mg/cm}^2$ . List any other constraints given by LBP survey. Contractor shall remove these items in accordance with all applicable Federal, State, and local laws, ordinances, regulations, court orders, or other types of rules or rulings having the effect of law.
- 1.13 **LABELING OF STORAGE DRUMS:** All 55 gallon or larger drums brought on base for use under this contract and containing new material or used for storage of waste materials or hazardous waste must be labeled with a Department of Transportation (DOT) Proper Shipping Name, DOT Hazardous Identification Number, the Contractor's name, a Contractor representative, and the Contractor's telephone number. Label lettering should have a minimum height of one half inch painted in white paint or other color that is in contrast with the color of the drum. The label should be sufficiently durable to equal or exceed the life (including storage and disposal) of the drum.
- 1.14 **CONTRACTOR STORAGE TRAILER(S) AND BUILDING(S):** The Contractor shall place or paint a sign on all of his storage trailer(s) and building(s) used on this contract. At a minimum, the sign shall contain the name of the Contractor and a telephone

number at which the Contractor can be reached. The trailer(s) and building(s) shall be complete with gates and/or doors which can be locked. Only material for this project shall be stored in the trailer(s) or building(s). The Contractor shall remove the storage trailer(s) or building(s) within 30 days after completion of the contract and prior to submitting his final invoice. The area around the storage trailer(s) and building(s) shall be kept clean. This includes the mowing of grass during the growing season. The lawn mower shall be supplied by the Contractor.

- 1.15 The Contractor will be given a lot in the Contractor Storage Area behind Bldg 2700 for the life of the contract. The Contractor's progress schedule shall include a line item (equal to 1%) for final cleanup of this storage lot. Final payment will not be made until this final cleanup is performed by the Contractor and accepted by Seymour Johnson AFB.

1.16 CONSTRAINTS:

- A. All contractor and subcontractor personnel shall provide and display an identification tag showing picture, name of company they represent, and their driver's license number. This identification shall be visible at all times. All vehicles operated by the contractor or subcontractors shall have visible identification showing name of represented company.

1.17 PHASING:

- A. The 30 days following Contractor's Notice to Proceed (Phase I) will be allowed for delivery of materials, equipment ordering, and submittal approval only. No on-site work shall be permitted by the Contractor during that initial 30 day period.
- B. After the submittal phase, the performance period (Phase II) will take 90 days.

1.18 AFFIRMATIVE PROCUREMENT:

- A. The contractor shall incorporate Affirmative Procurement requirements as per 40 CFR, Part 247 and Executive Order 13101: "Greening the Government Through Waste Prevention, Recycling and Federal Acquisition." Designated items used in the execution of this contract shall meet or exceed the Environmental Protection Agency's (EPA) requirements for recycled content materials (RCM) as per the EPA's Comprehensive Procurement Guidelines (CPG). The contractor/engineer shall ensure affirmative procurement requirements for CPG items are met or provide written justification that: 1) The price of a given designated item is unreasonably high, 2) There is inadequate competition (not enough sources of supply), 3) Unusual and unreasonable delays would result from obtaining the item, or 4) The item does not meet the Air Force's performance specifications.

END OF SECTION 01000

## **SECTION 02070**

### **SELECTIVE DEMOLITION**

#### **1.1 GENERAL**

##### **A. Definitions:**

1. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
2. Remove and Salvage: Detach items from existing construction and deliver them to the Government.
3. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
4. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

##### **B. Materials Ownership:** Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain the Government 's property, demolished materials shall become Contractor's property and shall be removed from Project site.

##### **C. Regulatory Requirements:** Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

##### **D. Standards:** Comply with ANSI A10.6 and NFPA 241.

##### **E. Project Conditions:**

1. The Government will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so the Government 's operations will not be disrupted. Provide not less than 48 hours' notice to the Government of activities that will affect the Government 's operations.
2. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
3. The Government assumes no responsibility for condition of areas to be selectively demolished.
4. Conditions existing at time of inspection for bidding purpose will be maintained by the Government as far as practical.
5. Storage or sale of removed items or materials on-site will not be permitted.

##### **F. Existing Warranties:** Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

#### **1.2 PRODUCTS**

- A. Repair Materials: Use repair materials identical to existing materials.
- B. If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
- C. Use materials whose installed performance equals or surpasses that of existing materials.

### 1.3 EXECUTION

- A. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- B. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to the Contracting Officer or authorized representative.
- C. Engage a professional engineer to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition operations.
- D. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
- E. Existing Utilities: Maintain services indicated to remain and protect them against damage during selective demolition operations.
- F. Utility Requirements: Locate, identify, disconnect, shut off, and seal or cap off indicated utilities serving areas to be selectively demolished.
- G. If utility services are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary utilities that bypass area of selective demolition and that maintain continuity of service to other parts of building.
- H. Dangerous Materials: Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with selective demolition operations.
- I. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- J. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.
- K. Protect existing site improvements, appurtenances, and landscaping to remain.
- L. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

- M. Temporary Enclosures: Provide temporary enclosures for protection of existing building and construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
- N. Temporary Partitions: Erect and maintain dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise.
- O. Dust Control: Use water mist, temporary enclosures, and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations.
- P. Disposal: Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- Q. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
- R. Cleaning: Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.
- S. Selective Demolition: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
- T. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction.
- U. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
- V. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
- W. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
- X. Existing Facilities: Comply with building manager's requirements for using and protecting elevators, stairs, walkways, loading docks, building entries, and other building facilities during selective demolition operations.
- Y. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by the Contracting Officer or authorized representative, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

- Z. Patching and Repairs: Promptly repair damage to adjacent construction caused by selective demolition operations.
- AA. Repairs: Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.
- BB. Finishes: Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.
- CC. Floors and Walls: Where walls or partitions that are demolished extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish color, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
- DD. Ceilings: Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.
- EE. Disposal of Demolished Materials: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
- FF. Burning: Do not burn demolished materials.
- GG. Disposal: Transport demolished materials off the Government's property and legally dispose of them.

END OF SECTION 02070

## **SECTION 02300**

### **EARTHWORK**

#### **1.1 Definitions in this Section include the following:**

- A. Backfill: Soil materials used to fill an excavation.
- B. Base Course: Layer placed between the subbase course and asphalt paving.
- C. Bedding Course: Layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations.
- G. Fill: Soil materials used to raise existing grades.
- H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- I. Subbase Course: Layer placed between the subgrade and base course for asphalt paving, or layer placed between the subgrade and a concrete pavement or walk.
- J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- K. Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.
- L. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Government or others unless permitted in writing and then only after arranging to provide temporary utility services according to requirements indicated.

#### **1.2 PRODUCTS**

- A. Soil Materials: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, and SM, or a combination of these group symbols; free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT, or a combination of these group symbols.

- D. Backfill and Fill: Satisfactory soil materials.
- E. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (38-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.
- F. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.
- G. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (38-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.
- H. Detectable Warning Tape: Polyethylene film warning tape encasing a metallic core, minimum 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility.

### 1.3 EXECUTION

- A. Preparation: Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Provide erosion- and sedimentation-control measures.
- C. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- D. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
- E. Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, and obstructions.
- F. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
- G. Excavate for structures, pavements, and walks to indicated elevations and dimensions. Extend excavations for placing and removing concrete formwork, for installing services and other construction, and for inspections. Trim bottoms to required lines and grades to leave solid base to receive other work.
- H. Excavate utility trenches to indicated gradients, lines, depths, and invert elevations of uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit.

- I. Excavate trenches deeper than bottom of pipe elevation, 6 inches (150 mm) deeper in rock, 4 inches (100 mm) deeper elsewhere, to allow for bedding course. Hand excavate for bell of pipe.
- J. Proof roll subgrades, before filling or placing aggregate courses, with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof roll wet or saturated subgrades.
- K. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities.
- L. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill may be used when approved by the Contracting Officer or authorized representative.
- M. Stockpile borrow materials and satisfactory soil materials, without intermixing, in shaped, graded, drained, and covered stockpiles. Stockpile soil materials away from edge of excavations and outside drip line of remaining trees.
- N. Utility Trench Backfill: Place, compact, and shape bedding course to provide continuous support for pipes and conduits over rock and other unyielding bearing surfaces and to fill unauthorized excavations.
- O. Place and compact initial backfill of satisfactory soil material or subbase material, free of particles larger than 1 inch (25 mm), to a height of 12 inches (300 mm) over the utility pipe or conduit. Place and compact final backfill of satisfactory soil material to final subgrade.
- P. Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.
- Q. Fill: Place and compact fill material in layers to required elevations.
- R. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.
- S. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.
- T. Compaction:
  - 1. When heavy compaction equipment is used: Place backfill and fill materials in layers not more than 8 inches (200 mm) in loose depth.
  - 2. When hand-operated tampers is used: Place backfill and fill materials in layers not more than 4 inches (100 mm) in loose depth.
- U. Compact soil to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill material at 95 percent.
  2. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill material at 92 percent.
  3. Under lawn or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill material at 85 percent.
- V. Grading: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated. Grade lawns, walks, and unpaved subgrades to tolerances of plus or minus 1 inch (25 mm) and pavements and areas within building lines to plus or minus 1/2 inch (13 mm).
- W. Subbase and Base Courses: Under pavements and walks, place subbase course on prepared subgrade. Place base course material over subbase. Compact to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.
- X. Under slabs-on-grade, place drainage course on prepared subgrade. Compact to required cross sections and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.
- Y. Testing Agency: The Contractor will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
1. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
  2. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.
- Z. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction.
- AA. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
- BB. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off the Government's property.

END OF SECTION 02300

## **SECTION 02510**

### **WATER DISTRIBUTION**

#### **1.1 GENERAL**

- A. Comply with requirements of authorized government representative supplying water.
- B. Comply with standards of authorized government representative for water-service piping.
- C. Comply with NSF 61 for materials for potable water.
- D. Provide listing/approval stamp, label, or other marking on piping and specialties made to specified standards.
- E. Submittals: Submit the following:
  - 1. Product Data: For valves (NRS, OS&Y, check), tapping sleeve and valve, underground piping materials and fittings, post indicator, back flow prevention device, fire department connection, and prefabricated vault.
  - 2. Approved Site Plan Drawings: Working plans, prepared according to NFPA 13 and 24 that have been approved by authorities having jurisdiction.
  - 3. Field test reports and certificates: Include "Contractor's Material and Test Certificate for Underground Piping", purging and disinfecting reports, and hydrostatic test.
  - 4. Warranty: Provide manufacturer's written warranty for pipe.
  - 5. Provide operating and test instructions for the backflow preventer.

#### **1.2 PRODUCTS**

- A. Pipes and Tubes: Applications of the following pipe and tube materials are indicated in "Piping Applications" Paragraph.
  - 1. Ductile-Iron, Push-on-Joint Pipe: AWWA C151, with cement-mortar lining and seal coat. Include rubber compression gasket.
- B. Pipe and Tube Fittings: Applications of the following pipe and tube fitting materials are indicated in "Piping Applications" Paragraph.
  - 1. Ductile-Iron, Push-on-Joint Fittings: AWWA C110, ductile-iron or cast-iron; or AWWA C153, ductile-iron, compact type. Include cement-mortar lining, seal coat, and rubber compression gaskets.
- C. Joining Materials: Applications of the following piping joining materials are indicated in "Piping Applications" Paragraph.
  - 1. Ductile-Iron Piping: The following materials apply:
    - a. Push-on Joints: AWWA C111 rubber gaskets and lubricant.

- b. Pipe Couplings: Iron-body sleeve assembly, fabricated to match OD of pipes to be joined. Include sleeve, followers, gaskets, bolts and nuts, and enamel-paint finish.
- D. Nonrising-Stem Gate Valves, 4-Inch NPS (DN100) and Larger: UL 262, FM approved, iron body and bonnet with flange for indicator post, bronze seating material, inside screw, 175-psig (1200-kPa) working pressure, and mechanical-joint ends. Provide with flanged ends for pit installation.
- E. Rising-Stem Gate Valves, 3-Inch NPS (DN80) and Larger: AWWA C509, resilient seated; cast-iron or ductile-iron body and bonnet, OS&Y, bronze stem, 200-psig (1380-kPa) working pressure, and flanged ends.
- F. Nonrising-Stem Gate Valves, 2-Inch NPS (DN50) and Smaller: MSS SP-80; body and screw bonnet of ASTM B 62 cast bronze; with Class 125 threaded ends, solid wedge, nonrising copper-silicon-alloy stem, brass packing gland, PTFE-impregnated packing, and malleable-iron handwheel.
- G. Valve Boxes: Cast-iron box with top section and cover with lettering "WATER," bottom section with base of size to fit over valve and barrel approximately 5 inches (125 mm) in diameter, and adjustable cast-iron extension of length required for depth of bury of valve. Include steel tee-handle wrench with each valve box.
- H. Double-Check-Detector Assembly Backflow Preventers: ASSE 1048, FM approved or UL listed, and suitable for continuous pressure application. Include outside screw and yoke gate valves on inlet and outlet equipped with tamper switches connected to building fire alarm control panel. Include test cocks; two positive-seating check valves; and bypass with displacement-type water meter, valves, and double-check backflow preventer.
- I. Maximum Pressure Loss: 5 psig (35 kPa) through middle 1/3 of flow range.
- J. CONCRETE VAULTS: Precast, reinforced-concrete vault, designed for A-16 load designation according to ASTM C 857 and made according to ASTM C 858. ASTM A 36/A 36M, steel or polyethylene-encased steel steps. Furnish with 4'-0" x 6'-0" double leaf, aluminum vault access door. Furnish with 2'-0" diameter gravel filled sump drain.
- K. Exposed, Freestanding, Sidewalk, Fire Department Connections: UL 405, cast-bronze body, with thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch-(460-mm-) high brass sleeve; and round escutcheon plate.
  - 1. Connections: Two NPS 2-1/2 (DN 65) inlets and one NPS 4 (DN 100) outlet.
  - 2. Finish Including Sleeve: Rough chrome plated.
  - 3. Round, Floor, Brass, Escutcheon Plate Marking: "AUTO SPKR."
- L. Indicator Posts: UL 789, FM-approved, vertical-type, cast iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of

burial valve. Provide tamper switch to be connected to building fire alarm control panel.

- M. Service Boxes for Curb Stops: Cast-iron box with telescoping top section of length required for depth of bury of valve. Include cover with lettering "WATER," and bottom section with base of size to fit over curb-stop and barrel approximately 3 inches (75 mm) in diameter. Include steel tee-handle shutoff rod with each service box.
- N. Ball Valves: AWWA C507, Class 250. Include interior coating according to AWWA C550.
- O. Tapping Sleeve and Tapping Valve: Complete assembly, including tapping sleeve, tapping valve, and bolts and nuts. Use sleeve and valve compatible with tapping machine.
- P. Tapping Sleeve: Cast- or ductile-iron, 2-piece bolted sleeve with flanged outlet for new branch connection. Sleeve may have mechanical-joint ends with rubber gaskets or sealing rings in sleeve body. Include sleeve matching size and type of pipe material being tapped and of outlet flange required for branch connection.
- Q. Anchorage Materials are as follows:
  - 1. Steel: ASTM A 506, clamps, straps, and washers; ASTM A 575, rods; and ASTM A 307, bolts.
  - 2. Iron: ASTM A 197 (ASTM A 197M), malleable-iron rod couplings and ASTM A 126, gray-iron washers.
- R. Concrete Reaction Backing (Thrust Blocks): Portland cement concrete mix, 3000 psig (20.7 MPa); with cement according to ASTM C 150, Type I; sand and crushed gravel according to ASTM C 33; and potable water. Minimum volume of thrust block shall be ½ c.y.
- S. Refer to Section 02300 "Earthwork" for underground warning tape materials. Arrange for warning tapes made of solid blue film with continuously printed black-letter caption "CAUTION--WATER LINE BURIED BELOW."

### 1.3 EXECUTION

- A. Refer to Section 02300 "Earthwork" for excavation, trenching, and backfilling.
- B. Piping Applications: Use pipe, fittings, and joining methods for piping systems according to the following applications:
  - 1. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below, unless otherwise indicated.
  - 2. Fire-Protection Water-Service Piping: Use ductile-iron, push-on-joint pipe and fittings; and gasketed joints.
- C. Valve Applications: Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Underground Valves, 4-Inch NPS (DN100) and Larger: UL/FM, gate valves, nonrising stem, with indicator post.
  2. Pit Installation Valves, 2-1/2-Inch NPS (DN65) and Larger: UL/FM, OS&Y gate valves.
  3. Pit Installation Valves, 2-Inch NPS (DN50) and Smaller: MSS, nonrising-stem gate valves.
- D. Joint Construction:
1. Ductile-Iron Piping, Gasketed Joints for Fire-Service Piping: According to UL 194 and AWWA C600.
- E. Piping Systems - Common Requirements: Drawings indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated, unless deviations to layout are approved by authorized government representative.
1. Install fittings for changes in direction and branch connections.
  2. Piping Connections: Unless otherwise indicated, make piping connections as specified below:
    - a. Install unions, in piping 2-inch NPS (DN50) and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS (DN50) or smaller threaded pipe connection.
    - b. Install flanges, in piping 2-1/2-inch NPS (DN65) and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
- F. Extend water-service piping and connect to water-supply source.
- G. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
- H. Terminate service-entry piping 1'-0" above building finished floor.
- I. Piping Installation: Install piping according to the following:
1. Water-Main Connection: Tap water main with size and in location as indicated according to requirements of water utility.
  2. Make connections larger than 2-inch NPS (DN50) with tapping machine according to manufacturer's written instructions and AWWA C600. Install valve with stem pointing up and with cast-iron valve box.
  3. Comply with NFPA 24 for fire-protection water-service piping materials and installation.
  4. Install ductile-iron piping according to AWWA C600.
  5. Bury piping with depth of cover over top at least 30 inches (750 mm), with top at least 12 inches (300 mm) below level of maximum frost penetration.

6. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
    - a. Gasketed-Joint, Ductile-Iron, Fire-Service Piping: According to NFPA 24.
    - b. Apply full coat of asphalt or other acceptable corrosion-retarding material to surfaces of installed ferrous anchorage devices.
  
  - J. Valve Installation: Use mechanical-joint-end valves for 3-inch NPS (DN80) and larger underground installation. Use threaded- and flanged-end valves for installation in pits. Use nonrising-stem UL/FM gate valves for installation with indicator posts.
    1. AWWA-Type Gate Valves: Comply with AWWA C600. Install underground valves with stem pointing up and with cast-iron valve box.
    2. UL/FM-Type Gate Valves: Comply with NFPA 24. Install underground valves and valves in pits with stem pointing up and with vertical cast-iron indicator post.
  
  - K. Install precast concrete pits according to ASTM C 891.
  
  - L. Install fire department connections of types and features indicated.
  
  - M. Install continuous plastic underground warning tape during back-filling of trench for underground water-service piping. Locate 6 to 8 inches (150 to 200 mm) below finished grade, directly over piping.
  
  - N. Conduct piping tests before joints are covered and after thrust blocks have hardened for 48 hours. Fill pipeline 24 hours before testing and apply test pressure to stabilize system.
  
  - O. Hydrostatic Tests: Test at 200 psi for 2 hours. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within above limits.
- 1.4 CLEANING
- A. Flush, clean and disinfect water distribution piping as follows:
    1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
    2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
    3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or as described below:
      - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
      - b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.

- c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
- d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 02510

## **SECTION 02511**

### **HOT-MIX ASPHALT PAVING**

- 1.1 Submittals: Product Data, material certificates, and the following:
- A. Job-Mix Designs: For each job mix proposed for the Work.
  - B. Installer Qualifications: Engage an experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
  - C. Manufacturer Qualifications: Manufacturer of hot-mix asphalt shall be a registered and approved paving mix manufacturer with authorities having jurisdiction or with the NCDOT.
  - D. Regulatory Requirements: Conform to applicable standards of authorities having jurisdiction for asphalt paving work on public property.
  - E. Asphalt-Paving Publication: Comply with AI's "The Asphalt Handbook," except where more stringent requirements are indicated.
  - F. Environmental Limitations: Do not apply asphalt materials if substrate is wet or excessively damp or if the following conditions are not met:
    - 1. Tack Coats: Minimum surface temperature of 60 deg F (15.5 deg C).
    - 2. Asphalt Base Course: Minimum surface temperature of 40 deg F (4 deg C) and rising at time of placement.
    - 3. Asphalt Surface Course: Minimum surface temperature of 60 deg F (15.5 deg C) at time of placement.
- 1.2 PRODUCTS
- A. Coarse Aggregate: Sound; angular crushed stone; crushed gravel; or properly cured, crushed blast-furnace slag; complying with ASTM D 692.
  - B. Fine Aggregate: Sharp-edged natural sand or sand prepared from stone; gravel, properly cured blast-furnace slag, or combinations thereof; complying with ASTM D 1073.
  - C. Mineral Filler: Rock or slag dust, hydraulic cement, or other inert material complying with ASTM D 242.
  - D. Asphalt Cement: ASTM D 3381 for viscosity-graded material; ASTM D 946 for penetration-graded material.
  - E. Tack Coat: ASTM D 977, emulsified asphalt or ASTM D 2397, cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.

- F. Herbicide: Commercial chemical for weed control, registered by Environmental Protection Agency (EPA). Provide granular, liquid, or wettable powder form.
- G. Wheel Stops: Precast, air-entrained concrete, 2500-psi (17.2-MPa) minimum compressive strength, approximately 9-1/2 inches high, 12 inches wide, and 84 inches long. Provide chamfered corners and drainage slots on underside, and provide holes and galvanized steel dowels for anchoring to substrate.
- H. Hot-Mix Asphalt: Provide dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI's "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:
  - 1. Base Course: As indicated.
  - 2. Surface Course: As indicated.

### 1.3 EXECUTION

- A. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.
  - 1. Before placing asphalt materials, remove loose and deleterious material from substrate surfaces.
- B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions.
- C. Tack Coat: Apply uniformly to existing surfaces of previously constructed asphalt or portland cement concrete paving and to surfaces abutting or projecting into new, hot-mix asphalt pavement. Apply at a uniform rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m) of surface. Allow tack coat to cure undisturbed before paving.
  - 1. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- D. Machine place base and surface courses of hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness, when compacted.
- E. Promptly correct surface irregularities in paving course behind paver. Remove excess material and fill depressions with hot-mix asphalt.
- F. Construct joints to ensure continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.
- G. Compact each hot-mix asphalt course to an average density of 96 percent of reference laboratory density according to ASTM D 1559, but not less than 94 percent nor greater than 100 percent, and to the following tolerances:

1. Thickness: Base course, plus or minus 1/2 inch (13 mm); surface course, plus 1/4 inch (6 mm), no minus.
  2. Surface Smoothness: Base course, 1/4 inch (6 mm); surface course, 1/8 inch (3 mm).
- H. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt compacted by rolling to specified density and surface smoothness.
- I. Apply pavement-marking paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 mm).
- J. Securely attach wheel stops into pavement with not less than 2 galvanized steel dowels embedded in precast concrete at one-third points. Firmly bond each dowel to wheel stop and to pavement.

END OF SECTION 02511

## **SECTION 02920**

### **LAWNS AND GRASSES**

#### **1.1 GENERAL**

- A. Submittals: In addition to Product Data for each type of product indicated, submit a planting schedule indicating anticipated planting date.
- B. Lawn Maintenance: Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:
  - 1. Seeded Lawns: 60 days from date of Substantial Completion.
  - 2. Mow lawn as soon as top growth is tall enough to cut. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings.

#### **1.2 PRODUCTS**

- A. Seed Species: Tall Fescue.
- B. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch (25 mm) or larger in any dimension and other extraneous materials harmful to plant growth.
  - 1. Topsoil Source: Reuse surface soil stockpiled on-site and supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Verify suitability of stockpiled surface soil to produce topsoil.
- C. Fertilizer:
  - 1. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in composition suitable for site conditions.
- D. Mulches:
  - 1. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

#### **1.3 EXECUTION**

- A. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off the Government's property.
  - 1. Apply fertilizer (if needed) directly to subgrade before loosening.

- B. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare surface soil as follows:
1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
  2. Loosen surface soil to a depth of at least of 6 inches. Apply fertilizer and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
  3. Remove stones larger than 2 inches in any dimension and sticks, roots, trash, and other extraneous matter.
  4. Legally dispose of waste material, including grass, vegetation, and turf, off the Government's property.
- C. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1 inch of finish elevation.
- D. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- E. Restore areas if eroded or otherwise disturbed after finish grading and before planting.
- F. Seeding Schedule:

	<u>Rate</u>	<u>Seeding Dates</u>	
Tall Fescue	100 lb/acre	Fall – Best	Aug. 25 – Sept. 15
		Fall – Possible	Aug. 20 – Oct. 15
		Late Winter	Feb. 15 – Mar. 21

#### Soil Amendments

Apply lime (ground agricultural limestone)      4,000 lb/acre

10-10-10 Fertilizer      1,000 lb/acre

1. Rake seed lightly into top 1/8 inch of topsoil, roll lightly, and water with fine spray.
2. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.
3. Protect seeded areas from hot, dry weather or drying winds within 24 hours after completing seeding operations. Soak and scatter uniformly to a depth of 3/16 inch and roll to a smooth surface.

- G. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
- H. Reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

END OF SECTION 02920

## SECTION 03300

### CAST-IN-PLACE CONCRETE

#### 1.1 GENERAL

- A. Submittals: In addition to Product Data, submit design mixes and the following for each concrete mix:
  - 1. Shop Drawings detailing fabrication, bending, and placement.
  - 2. Material certificates signed by product manufacturers certifying that product complies with requirements.
  - 3. Test results shall be reported in writing.
- B. Quality Assurance: Comply with ACI 301, "Specification for Structural Concrete," and ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
  - 1. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

#### 1.2 PRODUCTS

- A. Steel Reinforcement: As follows:
  - 1. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Synthetic Fiber:
  - 1. Fibrillated or monofilament polypropylene fibers engineered and designed for use in concrete, complying with ASTM C 1116, Type III, ½ to 1-1/2 inches long. Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than 1.5 lb/cu. yd.
- C. Concrete Materials: As follows:
  - 1. Portland Cement: ASTM C 150, Type I.
  - 2. Aggregate: ASTM C 33, uniformly graded, from a single source throughout the project.
  - 3. Water: ASTM C 94, shall be clean, fresh, free from oil, organic matter, or other deleterious substances.
  - 4. Air-Entraining Admixture: ASTM C 260, Products shall be (or approved equal):
    - a. Air-Mix or AEA 92 by the Euclid Chemical Company.
    - b. MB-VR by Master Builders.
    - c. Darex Series or Daravair Series by W.R. Grace & Co.
  - 5. Water-Reducing Admixture: ASTM C 494, Type A. Shall not contain more chloride ions than are present in municipal drinking water. Products shall be (or approved equal):
    - a. Eucon WR-75 by The Euclid Chemical Company.

- b. Pozzolith 200N by Master Builders.
  - c. WRDA Series by W.R. Grace & Co.
- 6. High-Range, Water-Reducing Admixture (Superplasticizer): ASTM C 494, Type F. Shall not contain more chloride ions than are present in municipal drinking water. Products shall be (or approved equal):
  - a. Eucon 37 by The Euclid Chemical Company.
  - b. Rheobuild 1000 by Master Builders.
  - c. ADVA Series or Davacon Series by W.R. Grace & Co.
- 7. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E. Shall not contain more chloride ions than are present in municipal drinking water. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least a year's duration) using an acceptable accelerated corrosion test method such as that using electrical potential measures. Products shall be (or approved equal):
  - a. Accelguard 80 by The Euclid Chemical Company.
  - b. Polarset or Lubricon NCA by W. R. Grace Company.
- 8. Water-Reducing and Retarding Admixture: ASTM C 494, Type D. Water Reducing, Retarding Admixture: Shall not contain more chloride ions than are present in municipal drinking water. Products shall be (or approved equal):
  - a. Eucon Retarder-75 by The Euclid Chemical Company.
  - b. Possolith 100XR by Master Builders.
  - c. Daratard-17 by W.R. Grace & Co.
- 9. Fly Ash: ASTM C 618, Type F. Fly ash shall be obtained from one source for the concrete delivered to the project and not exceed 20 percent of the total cementitious material.

D. Related Materials: As follows:

- 1. Self-Expanding Strip Waterstops: Rectangular or trapezoidal strip, sodium bentonite or other hydrophylic material.
- 2. Vapor Retarder: Polyethylene sheet, ASTM D 4397, thickness on Drawings.
- 3. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- 4. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- 5. Epoxy-Bonding Adhesive: ASTM C 881, two-component epoxy resin, of type, class, and grade to suit requirements.

E. Curing Materials: As follows:

- 1. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- 2. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry.
- 3. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

4. Clear, Solvent-Borne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
  5. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
  6. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
  7. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
- F. Concrete Mixes: Prepare design mixes, proportioned according to ACI 211.1 and ACI 301, with the following properties:
1. Compressive Strength (28 Days): 3,000 psi or as indicated on Drawings.
  2. Slump: 3 to 4 inches.
  3. Air Content: 4.5 to 7.0 percent for all exterior concrete subject to freezing and thawing.
- G. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.
- H. Non-shrink Grout:
1. The non-shrink grout shall be:
    - a. Euco NS by The Euclid Chemical Company.
    - b. Five Star Grout by the U.S. Grout Corporation.

The factory pre-mixed grout shall conform to ASTM C1107, "Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)." In addition, the grout manufacturer shall furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95 percent bearing under a 4' x 4' base plate.
  2. The high flow grout shall be used where high fluidity and/or increase placing time is required. Products shall be:
    - a. Euco Hi-Flow Grout by The Euclid Chemical Company.
    - b. Masterflow 928 by Master Builders.

The factory pre-mixed grout shall conform to ASTM C1107, "Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink)." In addition, the grout manufacturer shall furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95 percent bearing under a 18" x 36" base plate.

### 1.3 EXECUTION

- A. Design, construct, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads.

- B. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- C. Leave formwork, for beam soffits, joists, slabs, and other structural elements, that supports weight of concrete in place until concrete has achieved 28-day design compressive strength.
- D. Comply with ACI 318, ACI 301, and recommendations in ACI 347R for design, installation, and removal of shoring and reshoring.
- E. Vapor Retarder: Place, protect, and repair vapor-retarder sheets according to ASTM E 1643.
- F. Steel Reinforcement: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
  - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- G. Joints: Locate and install construction, isolation, and contraction joints.
- H. Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions.
- I. Concrete Placement: Deposit concrete continuously and avoid segregation. Deposit concrete in forms in horizontal layers no deeper than 24 inches, avoiding cold joints.
  - 1. Consolidate concrete with mechanical vibrating equipment.
  - 2. Screed and initial-float concrete floors and slabs using bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
  - 3. Comply with ACI 306.1 for cold-weather concrete placement.
  - 4. Place concrete according to recommendations in ACI 305R when hot-weather conditions exist.
- J. Finish formed surfaces as follows:
  - 1. Apply rough-formed finish, defined in ACI 301, to concrete surfaces indicated or not exposed to public view.
  - 2. Apply smooth-formed finish, defined in ACI 301, to concrete surfaces indicated and exposed to public view or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, or painting.
  - 3. Apply smooth-rubbed finish to smooth-formed finished concrete surfaces indicated or exposed to public view.

- K. **Finishing Floors and Slabs:** Comply with recommendations in ACI 302.1R for screeding, restraighening, and finishing operations for concrete surfaces. Finish unformed surfaces as follows:
1. **Float Finish:** Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing.
  2. **Trowel Finish:** Apply a hard trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system.
  3. **Nonslip Broom Finish:** Apply a nonslip broom finish to surfaces indicated and to exterior concrete platforms, steps, and ramps. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
- L. **Concrete Protection and Curing:** Protect concrete from excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing.
1. Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause excessive moisture loss.
  2. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
  3. Cure formed and unformed concrete for at least seven days by moisture curing, moisture-retaining-cover curing, or curing compound.
  4. Cure and seal floors and slabs with a curing and sealing compound according to manufacturer's written instructions.
- M. **Testing Agency:** Contractor shall engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement.
- N. **Testing Services:** Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. **Testing Frequency:** Obtain one composite sample for each day's pour of each concrete mix exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
  2. **Slump:** ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
  3. **Air Content:** ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.

4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.
  5. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
  6. Compression Test Specimens: ASTM C 31 cast and laboratory cure one set of four standard cylinder specimens for each composite sample.
  7. Compressive-Strength Tests: ASTM C 39; test two laboratory-cured specimens at 7 days and two at 28 days.
    - a. Test two field-cured specimens at 7 days and two at 28 days.
    - b. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.
- O. Defective Concrete: Repair and patch defective areas when approved. Remove and replace concrete that cannot be repaired and patched.

**END OF SECTION 03300**

## SECTION 07841

### THROUGH-PENETRATION FIRESTOP SYSTEMS

#### 1.1 GENERAL

- A. Performance Requirements: Provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly penetrated.
1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, as determined per ASTM E 814, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
  2. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, as determined per ASTM E 814, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:
    - a. Penetrations located outside wall cavities.
    - b. Penetrations located outside fire-resistive shaft enclosures.
    - c. Penetrations located in construction containing fire-protection-rated openings.
    - d. Penetrating items larger than 4-inch- (100-mm-) diameter nominal pipe or 16 sq. in. (100 sq. cm) in overall cross-sectional area.
  3. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that after curing do not deteriorate when exposed to these conditions both during and after construction.
    - a. For piping penetrations for wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
    - b. For floor penetrations with annular spaces exceeding 4 inches (100 mm) in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved either by installing floor plates or by other means.
  4. For through-penetration firestop systems exposed to view, provide products with flame-spread ratings of less than 25 and smoke-developed ratings of less than 450, as determined per ASTM E 84.
- B. Submittals: In addition to Product Data for each type of product specified, submit the following:
1. Shop Drawings: For each through-penetration firestop system, show each kind of construction condition penetrated, relationships to adjoining construction, and kind of penetrating item. Include firestop design designation of testing and inspecting agency acceptable to authorities having jurisdiction.

2. Product Certificates: Signed by manufacturers of through-penetration firestop system products certifying that products furnished comply with requirements.
  3. Product Test Reports: From a qualified testing agency indicating through-penetration firestop system complies with requirements, based on comprehensive testing of current products.
- C. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in "Performance Requirements" Paragraph:
1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
  2. Through-penetration firestop systems are identical to those tested per ASTM E 814 and bear classification marking of qualified testing and inspecting agency.

## 1.2 PRODUCTS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following (or approved equal):
1. DAP Inc.
  2. Firestop Systems Inc.
  3. Hilti Construction Chemicals, Inc.
  4. RectorSeal Corporation (The).
  5. 3M Fire Protection Products.
  6. Tremco.
  7. United States Gypsum Company.
- C. Firestopping, General: Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
- D. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with "Performance Requirements" Paragraph. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:
1. Permanent forming/damming/backing materials.

2. Temporary forming materials.
  3. Substrate primers.
  4. Collars.
  5. Steel sleeves.
- E. General: Provide through-penetration firestop systems containing the types of fill materials indicated in the Through-Penetration Firestop System Schedule at the end of this Section by reference to the types of materials described below. Fill materials are those referred to in directories of the referenced testing and inspecting agencies as fill, void, or cavity materials.
1. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
  2. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.
  3. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
  4. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.
  5. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
  6. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
  7. Mortars: Prepackaged, dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
  8. Silicone Sealants: Moisture-curing, single-component, silicone-based, neutral-curing elastomeric sealants.

### 1.3 EXECUTION

- A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Paragraph and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
- C. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:

1. The words: "Warning--Through-Penetration Firestop System--Do Not Disturb. Notify Building Management of Any Damage."
  2. Contractor's name, address, and phone number.
  3. Through-penetration firestop system designation of applicable testing and inspecting agency.
  4. Date of installation.
  5. Through-penetration firestop system manufacturer's name.
  6. Installer's name.
- D. Through-Penetration Firestop System Schedule: Where UL-classified systems are indicated, they refer to the alpha-alpha-numeric designations listed in UL's "Fire Resistance Directory" under product Category XHEZ.
1. Firestop Systems for Metallic Pipes, Conduit, or Tubing FS-<#>: Comply with the following:
    - a. UL-Classified Systems: [C-AJ-] [C-BJ-] [C-BK-] [F-A-] [F-B-] [F-C-] [W-J-] [W-K-] [W-L-] <Insert one or more four-digit numbers> [1001-1999].

END OF SECTION 07841

## SECTION 09900

### PAINTING

#### 1.1 GENERAL

- A. This Section includes surface preparation and field painting of exposed exterior and interior items and surfaces.
  - 1. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
- B. Paint exposed surfaces, except where the paint schedules indicate that a surface or material is not to be painted or is to remain natural. If the paint schedules do not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate colors. If the schedules do not indicate color or finish, the Contracting Officer will select from standard colors and finishes available.
- C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
  - 1. Labels: Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.
- D. Submittals: For each paint system specified, provide the following:
  - 1. Material List: Provide an inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
  - 2. Manufacturer's Information: Provide manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.
- E. Source Limitations: Obtain primers, and undercoat materials for each coating system from the same manufacturer as the finish coats.
- F. Deliver materials to the Project Site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label.
- G. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F (7 deg C). Maintain containers in clean condition, free of foreign materials and residue. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily.
- H. Project Conditions: Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

## 1.2 PRODUCTS

- A. Material Compatibility: Provide primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
- C. Colors: Provide color selections made by the Contracting Officer.
  - 1. Color 1: Fed Color 20040 (Brown).

## 1.3 EXECUTION

- A. Examine substrates, areas, and conditions under which painting will be performed for compliance with paint application requirements. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
- B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates.
- C. Preparation: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
- D. Cleaning: Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease before cleaning. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- E. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition.
  - 1. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with the Steel Structures Painting Council's (SSPC) recommendations.
    - a. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with the same primer as the shop coat.
  - 2. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

- F. Materials Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
1. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
  2. Use only thinners approved by paint manufacturer and only within recommended limits.
- G. Application: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
1. Paint colors, surface treatments, and finishes are indicated in the schedules.
  2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
  3. Provide finish coats that are compatible with primers used.
  4. The term "exposed surfaces" includes areas visible when permanent or built-in items are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
  5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
  6. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
  7. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
  8. Sand lightly between each succeeding enamel or varnish coat.
- H. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
1. The number of coats and the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
  2. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
  3. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.

- I. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
- J. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.
- K. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.
- L. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.
- M. Field Quality Control: The Government reserves the right to engage the services of an independent testing agency to sample the paint material being used. Samples of material delivered to the Project will be taken, identified, sealed, and certified in the presence of the Contractor.
  - 1. The testing agency will perform appropriate tests as required by the Government.
  - 2. If tests show material being used does not comply with specified requirements, the Contractor shall remove noncomplying paint from the site, pay for testing, and repaint surfaces previously coated with the rejected paint. If necessary, the Contractor may be required to remove rejected paint from previously painted surfaces if, on repainting with specified paint, the 2 coatings are incompatible.
- N. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site.
  - 1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.
- O. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Contracting Officer or Authorized Representative.
- P. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.
  - 1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

#### 1.4 PAINT SCHEDULE

- A. Ferrous Metal: Provide the following finish systems over ferrous metal. Primer is not required over shop-primed items.

1. Semi-Gloss, Acrylic-Enamel Finish: Two finish coats over a primer.
    - a. Primer: Quick-drying, rust-inhibitive, alkyd-based or epoxy-metal primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils.
    - b. First and Second Coats: Semi-gloss, acrylic-latex, exterior enamel applied at spreading rate recommended by manufacturer to achieve a total dry film thickness of not less than 2.8 mils.
- B. Zinc-Coated Metal: Provide the following finish systems over zinc-coated metal:
1. Semi-Gloss, Acrylic-Enamel Finish: Two finish coats over a primer.
    - a. Primer: Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.
    - b. First and Second Coats: Semi-gloss, acrylic-latex, exterior enamel applied at spreading rate recommended by manufacturer to achieve a total dry film thickness of not less than 2.8 mils.

END OF SECTION 09900

## SECTION 13916

### FIRE-SUPPRESSION SPRINKLERS

#### 1.1 GENERAL

- A. Design sprinkler working plans and obtain approval from authorized government representative.
- B. Design sprinkler piping according to the following and obtain approval from authorized government representative:
  - 1. Include 10 percent margin of safety for available water flow and pressure.
  - 2. Sprinkler Occupancy Hazard Classifications: As follows:
    - a. Office Areas: Ordinary Hazard, Group 1.
    - b. Hangar Bays: Ordinary Hazard, Group 2.
  - 3. Minimum Density for Automatic-Sprinkler Piping Design: As follows:
    - a. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm/sq. ft. over 1,500-sq. ft. (9.5 mL/s over 140-sq. m) area.
    - b. Ordinary Hazard Group 2 Occupancy: 0.20 gpm/sf. ft. over 3,000 sq. ft. (12.7 mL/s over 280 sq m) area.
  - 4. Maximum Protection Area per Sprinkler: As follows:
    - a. Office Areas: 130 sq. ft. (12.1 sq. m).
    - b. Hangar Bays: 80 sq. ft. (9.3 sq. m).
- C. Components and Installation: Capable of producing piping systems with 175-psig (1200-kPa) minimum working-pressure rating.
- D. Submittals: Submit the following:
  - 1. Product Data: For valves (NRS, OS&Y, alarm check), piping materials and fittings, pipe couplings, hangers and upper attachments, water motor gong, flow switch, tamper switch, sprinkler head guards, and all sprinkler types.
  - 2. Warranty: provide manufacturer's written warranty for pipe, pipe fittings, pipe couplings, and sprinkler heads.
  - 3. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction. Include hydraulic calculations.
  - 4. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping", and purging and disinfecting reports, and hydrostatic tests.
  - 5. Provide operating instructions for: flow switch, tamper switch, water motor gong, and alarm check valve.

- E. Manufacturer Qualifications: Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL's "Fire Protection Equipment Directory" and FM's "Fire Protection Approval Guide" and that comply with other requirements indicated.
- F. Sprinkler Components: Listing/approval stamp, label, or other marking by a testing agency acceptable to authorities having jurisdiction.
- G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- H. NFPA Standards: Equipment, specialties, accessories, installation, and testing complying with the following:
  - 1. NFPA 13, "Installation of Sprinkler Systems."

## 1.2 PRODUCTS

- A. Piping: Refer to "Piping Applications" Paragraph for applications of pipe, tube, fitting, and joining materials.
- B. Standard-Weight Steel Pipe: ASTM A 53, ASTM A 135, or ASTM A 795; Schedule 40 in NPS 6 (DN150) and smaller, and Schedule 30 in NPS 8 (DN200) and larger.
- C. Cast-Iron Threaded Flanges: ASME B16.1.
- D. Cast-Iron Threaded Fittings: ASME B16.4.
- E. Malleable-Iron Threaded Fittings: ASME B16.3.
- F. Steel, Threaded Couplings: ASTM A 865.
- G. Steel Welding Fittings: ASTM A 234/A 234M, ASME B16.9, or ASME B16.11.
- H. Steel Flanges and Flanged Fittings: ASME B16.5.
- I. Steel, Grooved-End Fittings: UL-listed and FM-approved, ASTM A 47 (ASTM A 47M), malleable iron or ASTM A 536, ductile iron; with dimensions matching steel pipe and ends factory grooved according to AWWA C606.
- J. Fire-Protection-Service Valves: UL listed and FM approved, with minimum 175-psig (1200-kPa) nonshock working-pressure rating. Valves for grooved-end piping may be furnished with grooved ends instead of type of ends specified.
  - 1. Gate Valves, NPS 2 (DN50) and Smaller: UL 262; cast-bronze, threaded ends; solid wedge; OS&Y; and rising stem.
  - 2. Indicating Valves, NPS 2-1/2 (DN65) and Smaller: UL 1091; ball-type, bronze body with threaded ends; and integral indicating device.
  - 3. Gate Valves, NPS 2-1/2 (DN65) and Larger: UL 262, iron body, bronze mounted, taper wedge, OS&Y, and rising stem. Include replaceable, bronze, wedge facing rings and flanged ends.

4. Swing Check Valves, NPS 2 (DN50) and Smaller: UL 312 or MSS SP-80, Class 150; bronze body with bronze disc and threaded ends.
  5. Swing Check Valves, NPS 2-1/2 (DN65) and Larger: UL 312, cast-iron body and bolted cap, with bronze disc or cast-iron disc with bronze-disc ring and flanged ends.
- K. Alarm Check Valves: UL 193, 175-psig (1200-kPa) working pressure, designed for horizontal or vertical installation, with cast-iron flanged inlet and outlet, or grooved outlet, bronze grooved seat with O-ring seals, and single-hinge pin and latch design. Include trim sets for bypass, drain, electric sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer. Drain shall be closed type.
- L. Ball Drip Valves: UL 1726, automatic drain valve, NPS 3/4 (DN20), ball check device with threaded ends.
- M. Automatic Sprinklers: With heat-responsive element complying with the following:
1. UL 199, for applications except residential.
- N. Sprinkler Types and Categories: Nominal 1/2-inch (12.7-mm) orifice for "Ordinary" and "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
- O. Sprinkler types, features, and options include the following:
1. Pendent sprinklers.
  2. Upright sprinklers.
  3. Vertical Sidewall.
- P. Sprinkler Finishes: Chrome-plated and bronze.
- Q. Sprinkler Escutcheons: Chrome-plated steel, one piece, flat, unless otherwise indicated.
- R. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.
- S. Specialty Sprinkler Fittings: UL listed and FM approved; made of steel, ductile iron, or other materials compatible with piping.
- T. Locking-Lug Fittings: Unacceptable.
- U. Mechanical-Cross Fittings: UL 213, ductile-iron housing with pressure-responsive gaskets, bolts, and threaded or locking-lug outlets.
- V. Drop-Nipple Fittings: UL 1474, with threaded inlet, threaded outlet, and seals; adjustable.
- W. Sprinkler, Drain and Alarm Test Fittings: UL-listed, cast- or ductile-iron body; with threaded inlet and outlet, test valve, and orifice and sight glass.

- X. Sprinkler, Branch-Line Test Fittings: UL-listed, brass body; with threaded inlet and capped drain outlet and threaded outlet for sprinkler.
- Y. Sprinkler, Inspector's Test Fittings: UL-listed, cast- or ductile-iron housing; with threaded inlet and drain outlet and sight glass.
- Z. Water-Motor-Operated Alarms: UL 753, mechanical-operation type with pelton-wheel operator with shaft length, bearings, and sleeve to suit wall construction and 10-inch- (250-mm-) diameter, cast-aluminum alarm gong with red-enamel factory finish. Include NPS 3/4 (DN20) inlet and NPS 1 (DN25) drain connections.
- AA. Water-Flow Indicators: UL 346; electrical-supervision, vane-type water-flow detector; with 250-psig (1725-kPa) pressure rating; and designed for horizontal or vertical installation. Include two single-pole, double-throw, circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
- BB. Valve Supervisory Switches: UL 753; electrical; single-pole, double throw; with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
- CC. Pressure Gages: UL 393, 3-1/2- to 4-1/2-inch- (90- to 115-mm-) diameter dial with dial range of 0 to 250 psig (0 to 1725 kPa).

### 1.3 EXECUTION

- A. Preparation: Fire-hydrant flow tests are indicated on Drawing F2. Use results for system design calculations. Any additional tests shall be performed by base personnel.
- B. Piping Applications: Use according to the following:
  - 1. Do not use welded joints with galvanized steel pipe.
  - 2. Flanges, unions, and transition and special fittings with pressure ratings the same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
  - 3. Underground Service-Entrance Piping: See Section 02510.
  - 4. Sprinkler Feed Mains and Risers: Use the following:
    - a. NPS 4 (DN100) and Smaller: Standard-weight steel pipe with threaded ends, cast- or malleable-iron threaded fittings, and threaded joints.
    - b. NPS 6 (DN150) and Smaller: Standard-weight steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.
    - c. NPS 6 (DN150) and Smaller: Standard-weight steel pipe with plain ends, steel welding fittings, and welded joints.
    - d. NPS 6 (DN150) and Smaller: Schedule 40 steel pipe with threaded ends, cast- or malleable-iron threaded fittings, and threaded joints.

5. Wet-Pipe, Sprinkler Branch Piping: Use the following:
  - a. Sprinkler-Piping Option: Specialty sprinkler fittings, NPS 2 (DN50) and smaller, including mechanical-T fittings, may be used downstream from sprinkler zone valves.
  - b. NPS 1-1/2 (DN40) and Smaller: Standard-weight steel pipe with threaded ends, cast- or malleable-iron threaded fittings, and threaded joints.
  - c. NPS 1-1/2 (DN40) and Smaller: Standard-weight steel pipe with plain ends, steel welding fittings, and welded joints.
  - d. NPS 2 (DN50): Standard-weight steel pipe with threaded ends, cast- or malleable-iron threaded fittings, and threaded joints.
  - e. NPS 2 (DN50): Standard-weight steel pipe with cut grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.
  - f. NPS 2 (DN50): Standard-weight steel pipe with plain ends, steel welding fittings, and welded joints.
  - g. NPS 2-1/2 to NPS 3-1/2 (DN65 to DN90): Standard-weight steel pipe with plain ends, steel welding fittings, and welded joints.
- C. Valve Applications: Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  1. Fire-Protection-Service Valves: UL listed and FM approved for applications where required by NFPA 13.
    - a. Shutoff Duty: Use gate valves.
  2. General-Duty Valves: For applications where UL-listed and FM-approved valves are not required by NFPA 13.
    - a. Shutoff Duty: Use gate valves.
- D. Joint Construction:
  1. Steel-Piping, Grooved Joints: Use Schedule 40 steel pipe with cut-grooved ends and Schedule 30 or thinner steel pipe with roll-grooved ends; steel, grooved-end fittings; and steel, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
  2. Locking-Lug-Fitting, Twist-Locked Joints: Unacceptable.
  3. Provide "Mega-Lug" flange on service entrance piping for connection of interior flanged piping.
- E. Service-Entrance Piping: Connect interior sprinkler piping to underground water-service piping of size and in location indicated on drawing detail A/F3 for service entrance to building. Install shutoff valve, pressure gage, drain, and other accessories indicated at connection to water-service piping.
- F. Piping Installation:
  1. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as

practical. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval before deviating from approved working plans.

2. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
  3. Install unions adjacent to each valve in pipes NPS 2 (DN50) and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.
  4. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 (DN65) and larger connections.
  5. Install "Inspector's Test Connections" in sprinkler piping, complete with shutoff valve, sized and located according to NFPA 13.
  6. Install sprinkler piping with drains for complete system drainage.
  7. Install alarm devices in piping systems.
  8. Hangers and Supports: Comply with NFPA 13 for hanger materials and installation. Hangers and upper attachments shall be UL listed and FM approved.
  9. Install piping with grooved joints according to manufacturer's written instructions. Construct rigid piping joints, unless otherwise indicated.
  10. Install pressure gages on riser or feed main and at each sprinkler test connection. Include pressure gages with connection not less than NPS 1/4 (DN8) and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
  11. Install specialty sprinkler fittings according to manufacturer's written instructions.
- G. Valve Installation: Install fire-protection specialty valves, trim, fittings, controls, and specialties according to NFPA 13, manufacturer's written instructions, and authorities having jurisdiction.
1. Gate Valves: Install fire-protection-service valves supervised-open, located to control sources of water supply except from fire department connections. Provide permanent identification signs indicating portion of system controlled by each valve.
  2. Alarm Check Valves: Install valves in vertical position for proper direction of flow, including bypass check valve and retard chamber drain-line connection.
- H. Sprinkler Applications: Use sprinklers according to the following:
1. Rooms without Ceilings: Upright sprinklers.
  2. Rooms with Suspended Ceilings: Pendent sprinklers.
  3. Spaces Subject to Freezing: Upright; pendent, dry-type; and sidewall, dry-type sprinklers.
  4. Sprinkler Finishes: Use sprinklers with the following:

- a. Upright, Pendent, and Sidewall Sprinklers: Chrome-plated in finished spaces exposed to view and rough bronze in unfinished spaces.
- I. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical panels.
- J. Connect water supplies to sprinklers.
- K. Connect piping to specialty valves, specialties, and accessories.
- L. Electrical Connections: Power wiring is specified in Division 16.
- M. Connection of alarm devices to fire alarm will be performed by Division 16.
- N. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13. This includes hydraulic design information sign.
- O. Flush, test, and inspect sprinkler piping according to NFPA 13, "System Acceptance" Chapter.

END OF SECTION 13916

## **SECTION 13921**

### **ELECTRIC-DRIVE, HORIZONTAL FIRE PUMPS, VERTICALLY MOUNTED**

#### **1.1 SUMMARY**

- A. This Section includes electric-drive, single-stage, vertically mounted, split-case fire pumps for building fire-suppression systems.

#### **1.2 SUBMITTALS**

- A. Product Data: Include rated capacities, certified pump performance curves with each selection point indicated, furnished specialties, and accessories for each fire-pump and pressure-maintenance-pump unit and controllers.
- B. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and maintenance data for fire pump and controller.
- D. Warranty: for fire pump and controller.

#### **1.3 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Firms whose fire pumps, pressure-maintenance pumps, drivers, controllers, and accessories are listed by product name and manufacturer in UL's "Fire Protection Equipment Directory" and FMG's "Fire Protection Approval Guide" and that comply with requirements indicated. The following are exceptions and are not required:
  - 1. UL listing and FMG approval of pressure-maintenance pumps.
  - 2. FMG approval of pressure-maintenance-pump controllers.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 20, "Centrifugal Fire Pumps," for fire pumps, drivers, controllers, accessories, and installation.

#### **1.4 MANUFACTURERS**

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

#### **1.5 SINGLE-STAGE, VERTICALLY MOUNTED, SPLIT-CASE FIRE PUMPS**

- A. Description: UL 448, factory-assembled and -tested, electric-drive, double-suction, horizontal type vertically mounted on frame. Include pump and driver mounted on same base and connected with coupling.

1. Manufacturers (or approved equal):
  - a. Armstrong Darling, Inc.
  - b. Fairbanks Morse Pump Corp.
  - c. General Signal Pump Group; Aurora Pump Unit.
  - d. ITT Fluid Technology Corp.; ITT A-C Pump Unit.
  - e. Paco Pumps, Inc.
  - f. Patterson Pump Co.
  - g. Peerless Pump Co.
2. Characteristics: Capable of furnishing not less than 150 percent of rated capacity at not less than 65 percent of total rated head. Shutoff head is limited to 140 percent of total rated head.
3. Casing: Axially split cast iron with suction and discharge flanges machined to ASME B16.1, Class 125 dimensions, unless Class 250 flanges are indicated.
4. Impeller: Cast bronze of construction to match fire pump, statically and dynamically balanced, and keyed to shaft.
5. Wear Rings: Replaceable, bronze.
6. Shaft and Sleeve: Steel shaft with bronze sleeve.
7. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
8. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
9. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
10. Driver: Electric motor, 208v/3&.
11. Finish: Manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.
12. Nameplate: Complete with capacities, characteristics, and other pertinent data.
13. Confirmed required pump rotation to allow pump access.

## 1.6 PRESSURE-MAINTENANCE PUMPS

- A. Description: Factory-assembled and -tested, electric-drive pumps with cast-iron or stainless-steel casing and bronze or stainless-steel impellers and mechanical seals. Include flanged suction and discharge flanges machined to ASME B16.1, Class 125 dimensions, unless Class 250 flanges are indicated and except that connections may be threaded in sizes where flanges are not available. Comply with HI 1.1-1.5 requirements for regenerative-turbine centrifugal pumps. Include base, manufacturer's standard color paint, and nameplate.

1. Manufacturers:

- a. Crane Pumps & Systems, Inc.
  - b. Fairbanks Morse Pump Corp.
  - c. General Signal Pump Group; Aurora Pump Unit.
  - d. Grundfos Pumps Corp.
  - e. Paco Pumps, Inc.
- B. Pump Drivers: NEMA MG 1, open-drip-proof, squirrel-cage, induction motor, 208v/3&. Include construction complying with NFPA 20 and NFPA 70, and include wiring compatible with controller used, manufacturer's standard red paint, and nameplate.

## 1.7 PUMP CONTROLLERS

- A. Description: Combined automatic and nonautomatic operation; factory assembled and wired; factory tested for capacities and electrical characteristics; and with the following features:
- 1. Manufacturers:
    - a. Firetrol, Inc.
    - b. Hubbell Industrial Controls, Inc.
    - c. Joslyn Clark Controls, Inc.
    - d. Master Control Systems, Inc.
    - e. Metron, Inc.
  - 2. Enclosure: UL 50, Type 2, drip-proof, indoor.
  - 3. Controls, devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
  - 4. Nameplate: Complete with capacity, characteristics, approvals and listings.
  - 5. Controller Sensing Pipes: Fabricate according to NFPA 20.
- B. Full-Service, Fire-Pump Controllers: UL 218 and NFPA 20; listed for electric-drive, fire-pump service and service entrance.
- 1. Type Starting: Wye-delta, closed transition.
  - 2. Rate controllers for scheduled horsepower. Include short-circuit withstand rating at least equal to short-circuit current available at controller location. Take into account cable size and distance from substation or supply transformers.
  - 3. Controllers: As follows:
    - a. Isolating means and circuit breaker.
    - b. "Power on" pilot lamp.
    - c. Fire alarm system connections for indicating motor running condition, loss-of-line power, and line-power phase reversal.
    - d. Automatic and manual operation, and minimum run-time relay to prevent short cycling.
    - e. Automatic and manual shutdown.
    - f. System pressure recorder, electric ac driven with spring backup.
    - g. Mounting: Floor-stand type for field electrical connections.
    - h. Enclosure Finish: Manufacturer's standard red paint.

- C. Pressure-Maintenance-Pump Controllers: UL 508; factory-assembled, -wired, and -tested across-the-line type for combined automatic and nonautomatic operation.

1. Manufacturers:

- a. Firetrol, Inc.
- b. Hubbell Industrial Controls, Inc.
- c. Joslyn Clark Controls, Inc.
- d. Master Control Systems, Inc.
- e. Metron, Inc.

2. Enclosure: UL 508 and NEMA 250, Type 2, wall-mounting type for field electrical wiring.
3. Rate controller for scheduled horsepower and include fusible disconnect switch, pressure switch, hand-off-auto selector switch, pilot light, running period timer, and manufacturer's standard color paint.

1.8 FIRE-PUMP SPECIALTIES AND ACCESSORIES

- A. Match fire-pump suction and discharge ratings as required for fire-pump capacity rating. Include the following:

1. Automatic air-release valve.
2. Circulation relief valve.
3. Suction and discharge pressure gages.
4. Eccentric-tapered reducer at suction inlet.
5. Concentric-tapered reducer at discharge outlet.
6. Test-Header Manifold: Ductile-iron or brass body for hose valves. Include nozzle outlets arranged in single line; horizontal, flush-wall mounting attachment; and rectangular, brass escutcheon plate with lettering equivalent to "PUMP TEST CONNECTION."
7. Escutcheon Plate Finish: Rough chrome-plated.
8. Hose Valves: UL 668, straightway pattern, bronze with cap and chain. Include NFPA 1963 hose thread that complies with local fire department standards and finish same as for test-header-manifold escutcheon plate.
9. Ball Drip Valve: UL 1726.
10. Main Relief Valve: UL 1478, none required.

1.9 PRESSURE-MAINTENANCE-PUMP SPECIALTIES AND ACCESSORIES

- A. Match pressure-maintenance-pump suction and discharge ratings as required for pump capacity rating. Include circulation relief valve and suction and discharge pressure gages.

1.10 ALARM PANELS

- A. Factory-assembled and -wired remote panel complying with UL 508 and requirements in NFPA 20. Include audible and visible alarms matching controller type.
  - 1. Manufacturers:
    - a. Firetrol, Inc.
    - b. Hubbell Industrial Controls, Inc.
    - c. Joslyn Clark Controls, Inc.
    - d. Master Control Systems, Inc.
    - e. Metron, Inc.
    - f. Or approved equal.
  - 2. Enclosure: NEMA 250, Type 2, remote wall-mounting type.
  - 3. Enclosure Finish: Manufacturer's standard red paint.
  - 4. Features: Include motor-operating condition, loss-of-line power, and phase reversal.

#### 1.11 SOURCE QUALITY CONTROL

- A. Factory Tests: Hydrostatically test and test run fire pumps before shipping. Test at 150 percent of shutoff head plus suction head, but not less than 250 psig (1725 kPa). Produce certified test curves showing head capacity and brake horsepower of each pump.

#### 1.12 INSTALLATION

- A. Install concrete bases of dimensions indicated for fire pumps, pressure-maintenance pumps, and controllers. Refer to Division 3 Section "Cast-in-Place Concrete".
- B. Comply with fire-pump, pressure-maintenance-pump, and controller manufacturers' written installation and alignment instructions, and with NFPA 20.
- C. Install pumps and controllers to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories for vertically mounted pump, ensure that impeller casing is accessible from hangar bay side of pump.
- D. Set pumps on concrete bases. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed.
  - 1. Support pump baseplate on rectangular metal blocks and shims or on metal wedges having small taper, at points near foundation bolts to provide 3/4- to 1-1/2-inch (19- to 38-mm) gap between pump base and foundation for grouting.
  - 2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and pump suction and discharge flanges to verify that they are level and plumb.
- E. Install suction and discharge piping equal to or greater than diameter of fire-pump nozzles.

- F. Install valves that are the same size as piping connecting fire pumps, bypasses, test headers, and other piping systems.
- G. Install pressure gages on fire-pump suction and discharge at pressure-gage tapplings.
- H. Support pumps and piping separately so weight of piping does not rest on pumps.
- I. Install piping accessories, hangers and supports, anchors, valves, meters and gages, and equipment supports.
- J. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted. Furnish copies of manufacturers' wiring diagram Submittals to electrical Installer. Verify that electrical wiring is installed according to manufacturers' submittal and installation requirements in Division 16 Sections. Proceed with equipment startup only after wiring installation is satisfactory.

#### 1.13 ALIGNMENT

- A. Align fire-pump and driver shafts after complete unit has been leveled on foundation, grout has set, and foundation bolts have been tightened.
  - 1. After alignment is correct, tighten foundation bolts evenly but not too firmly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten foundation bolts after grout has hardened. Check alignment and make required corrections.
  - 2. Make piping connections, check alignment, and make required corrections. Adjust alignment of pump and driver shafts for angular and parallel alignment by one method in HI 1.1-1.5, Section 1.4, "Installation, Operation and Maintenance." Comply with manufacturer's written instructions for alignment tolerances.

#### 1.14 CONNECTIONS

- A. Piping installation requirements are specified in other Division 13 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:
  - 1. Install piping adjacent to fire and pressure-maintenance pumps to allow service and maintenance.
  - 2. Connect water supply to fire and pressure-maintenance pumps.
  - 3. Connect fire-pump and pressure-maintenance-pump discharge piping to building fire-suppression piping.
  - 4. Connect circulation relief-valve discharge to point of disposal.
- B. Connect fire-pump controllers to building fire alarm system. Refer to Division 13 Section "Fire Alarm."
- C. Connect controllers to pumps.
- D. Electrical wiring and connections are specified in Division 16 Sections.

## 1.15 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including fire-pump and pressure-maintenance-pump units, piping, and electrical connections. Report results in writing.
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Perform field tests for each fire-pump unit and system piping when installation is complete. Comply with operating instructions and procedures in NFPA 20 to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected or that does not perform as indicated, then retest to demonstrate compliance. Verify that each fire-pump unit performs as indicated. Report test results in writing.

END OF SECTION 13921

## **SECTION 16060**

### **GROUNDING AND BONDING**

#### **1.1 SUMMARY**

- A. Extent of electrical grounding and bonding work is indicated by the Drawings and Schedules and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment.
- B. Type of electrical grounding and bonding work specified in this section includes the following:
  - 1. Solidly grounded.
  - 2. Applications of electrical grounding and bonding work in this section includes the following:
    - a. Electrical power systems.
    - b. Raceways.
    - c. Enclosures.
    - d. Equipment.
  - 3. Refer to other Division 16 sections for wires/cables, electrical raceways, boxes and fittings, and wiring devices which are required in conjunction with electrical grounding and bonding work.

#### **1.2 QUALITY ASSURANCE**

- A. Manufacturer's Qualifications: Install grounding and bonding products of firms regularly engaged in the manufacture of these materials, including stranded cable, grounding rods, and bonding jumpers.
- B. Electrical Code Compliance: Comply with the applicable State electrical code requirements of the authority having jurisdiction, and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits and equipment.
- C. UL Compliance: Comply with applicable requirements of UL Standards No.'s 467, "Electrical Grounding and Bonding Equipment," and 869, "Electrical Service Equipment," pertaining to grounding and bonding of systems, circuits and equipment. In addition, comply with UL Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are UL listed and/or labeled for their intended usage.

#### **1.3 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering grounding products which may be incorporated in the work include, but are not limited to, the following (or approved equal):
  - 1. B-Line Systems, Inc.
  - 2. Burndy Corporation.

3. Gould Inc.
4. Ideal Industries, Inc.
5. Thomas & Betts Corp.

#### 1.4 MATERIALS AND PRODUCTS

- A. General: Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, bonding jumpers, and additional accessories needed for a complete installation.
  1. Where more than one type component product meets indicated requirements, selection is Contractor's option.
  2. Where materials or components are not indicated, provide products which comply with NEC and UL requirements and with established industry standards for those applications indicated.
  3. Conductors: Unless otherwise indicated, provide electrical grounding conductors for grounding system connections that match power supply wiring materials and are sized according to NEC.
  4. Bonding Connectors, Terminals and Clamps: Provide electrical bonding connectors, terminals, lugs and clamps as recommended by bonding connector, terminal and clamp manufacturers for indicated applications.
  5. Electrical Grounding Connection Accessories: Provide electrical insulating tape, bonding straps, as recommended by accessories manufacturers for type service indicated.

#### 1.5 EXECUTION

##### A. TESTING

1. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester.
  - a. Where tests show resistance-to-ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms, or less, by driving additional ground rods or by utilizing chemical treated rods.
  - b. Retest grounding system to demonstrate compliance.
2. Provide written certified testing report indicating resistance-to-ground value.
3. Provide testing per NFPA requirements, including impedance testing for all exposed metal electrical equipment below 7'-6" AFF.

##### B. EXAMINATION

1. Examine areas and conditions under which electrical grounding and bonding connections are to be made and notify the Contracting Officer or authorized representative in writing of conditions detrimental to proper completion of work.
2. Do not proceed with work until unsatisfactory conditions have been corrected.

##### C. INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

1. General: Install electrical grounding and bonding systems as indicated, in accordance with manufacturer's instructions and applicable portions of NEC, OSHA, and NECA's "Standard of Installation," and in accordance with recognized industry practices to ensure that products comply with requirements.
2. Install grounding systems as designed and submit certified test report on grounding system.
3. Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.
4. Provide a separate, insulated equipment grounding conductor from each device to ground buses in panelboards. Terminate each end on a grounding lug, bus, or insulated grounding bushing.
5. Provide grounding system per the Drawings and Article 250 of the NEC. Provide green equipment grounding conductor for all electrical raceways.
6. Provide bonding jumper from each controller to building steel and to existing building grounding system.
7. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.
8. Apply corrosion-resistant finish to field connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.
9. Provide clamp-on connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.
10. Provide PVC conduit for ground wire in concrete. Do not use metallic conduit.

END OF SECTION 16060

## **SECTION 16120**

### **CONDUCTORS AND CABLES**

#### **1.1 GENERAL**

##### **A. SUMMARY**

1. Extent of electrical wire and cable work is indicated by the Drawings and Schedules for low voltage wire and cable - 600V and below.
2. Types of electrical wire, cable, and connectors specified in this section include but are not limited to the following:
  - a. Copper conductors.
  - b. Fixture wires.
  - c. Tap type connectors.
  - d. Split-bolt connectors.
  - e. Wirenut connectors.
3. Applications of electrical wire, cable, and connectors required for this Project include but are not limited to the following:
  - a. For power distribution circuits.
  - b. For building lighting circuits.
  - c. For appliance and equipment circuits.
  - d. For motor-branch circuits.

##### **B. SUBMITTALS**

1. Product Data: For each type of product specified.

##### **C. QUALITY ASSURANCE**

1. Manufacturers: Firms regularly engaged in manufacture of electrical wire and cable products of types, sizes, and ratings required.
2. NEC Compliance: Comply with NEC requirements as applicable to construction, installation and color coding of electrical wires and cables.
3. UL Compliance: Provide wiring/cabling and connector products which are UL listed and/or labeled.

##### **D. DELIVERY, STORAGE, AND HANDLING**

1. Deliver wire and cable properly packaged in factory-fabricated type containers, or wound on NEMA-specified type wire and cable reels.
2. Store wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.
3. Handle wire and cable carefully to avoid abrading, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

#### **1.2 PRODUCTS**

A. MANUFACTURERS

1. Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of wire, cable, and connector) (or approved equal):
2. Wire and Cable:
  - a. American Insulated Wire Corp.
  - b. Cabelec Corp.
  - c. General Cable Corp.
  - d. Okonite Company.
  - e. Rome Cable Corp.
  - f. Southwire Company.
  - g. Triangle PWC, Inc.
3. Connectors:
  - a. AMP, Inc.
  - b. Appleton Electric Co.; Emerson Electric Co.
  - c. Electrical Products Div.; Midland-Ross Corp.
  - d. Ideal Industries, Inc.
  - e. 3M Company
  - f. O-Z/Gedney Co.
  - g. Square D Company.
  - h. Thomas & Betts Corp.

B. SECONDARY VOLTAGE WIRES, CABLES, AND CONNECTORS

1. General: Provide electrical wires, cables, and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer, for a complete installation, and for application indicated. Provide copper conductors with conductivity of not less than 98% at 68° F.
2. Building Wires: Provide factory-fabricated wires of sizes, ampacity ratings, and materials for applications and services indicated. Where not indicated, provide proper wire selection as determined by Contractor to comply with project's installation requirements, NEC and NEMA standards. Select from the following UL types, those wires with construction features which fulfill project requirements:
  - a. Type THW: For dry and wet locations; maximum operating temperature 75 degrees C (167 degrees F). Insulation, flame-retardant, moisture- and heat-resistant, thermoplastic; conductor, annealed copper.
  - b. Type THWN: For dry and wet locations; maximum operating temperature 75 degrees C (167 degrees F). Insulation, flame-retardant, moisture- and heat-resistant, thermoplastic; outer covering, nylon jacket; conductor, annealed copper.
  - c. Type RHW (Feeders 4/0 and larger and Underground Feeders): For dry and wet locations; maximum operating temperature 75 degrees C (167 degrees F). Insulation, moisture- and heat-resistant EP rubber; outer covering, moisture-resistant, flame-retardant, nonmetallic covering; conductor, annealed copper.
  - d. Type THHN (Interior Branch Circuits): For dry and damp locations; maximum operating temperature 90 degrees C (194 degrees F).

Insulation, flame-retardant, heat-resistant, thermoplastic; outer covering, nylon jacket; conductor, annealed copper.

3. Cables: Provide UL type factory-fabricated cables of sizes, ampacity ratings, and materials and jacketing/sheathing as indicated for services indicated. Where not indicated, provide proper selection as determined by Contractor to comply with installation requirements, NEC and NEMA standards.
4. Conductors No. 10 and smaller may be solid or stranded and conductors larger than No. 10 shall be stranded. Control wire shall be stranded copper.
5. Connectors:
  - a. General: Provide UL type factory-fabricated, metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated.
  - b. Where not indicated, provide proper selection as determined by the Installer to comply with the project's installation requirements, and with NEC and NEMA standards.
  - c. Select from the following, those types, classes, kinds and styles of connectors to fulfill project requirements:
    - 1) Type: Pressure, threaded.
    - 2) Class: Insulated.
    - 3) Kind: Copper (for Cu to Cu connection).
    - 4) Style: Tap, pigtail, wirenut, split bolt, T-connections.

### 1.3 TESTING

#### A. INSTALLATION OF WIRES AND CABLES

1. General: Install wires and wiring connectors as indicated, in compliance with applicable requirements of NEC, NEMA, OSHA, UL, and NECA's "Standard of Installation," and in accordance with recognized industry practices.
2. Coordinate wire/cable installation work including electrical raceway and equipment installation work, as necessary to properly interface installation of wires/cables with other work.
3. Use no wire smaller than 12 AWG for power and lighting circuits, and no smaller than 14 AWG for control wiring (fire alarm).
4. Use 10 AWG conductor for 20 ampere, 120 volt branch circuit home runs longer than 50 feet, unless otherwise noted on the Drawings.
5. Place an equal number of conductors for each phase of a circuit in same raceway, unless indicated otherwise on the Drawings.
6. Neatly train and lace wiring inside boxes, equipment and panelboards.
7. Make conductor lengths for parallel circuits equal.
8. Conductors shall be color coded; (1) ground leads, green; (2) grounded neutral leads, white (120 volts); (3) ungrounded phase wires, black, red, and blue (208Y/120V); (4) ungrounded phase wires, brown, orange, and yellow (480Y/277V); (5) switch leg travellers, purple.
9. Install exposed cables parallel and perpendicular to surfaces, or exposed structural members, and follow surface contours, where possible.

10. Completely and thoroughly swab raceway system before installing conductors.
11. Branch circuit wiring shall not loop through receptacle terminals, but shall be connected by means of conductor taps joined to branch circuit conductors. At end of run, branch circuit conductors may terminate on receptacle terminals.
12. Position all splices in pull boxes and junction boxes of adequate volume so they are accessible from the removable cover side of the box.
13. Conductors for signal systems shall be continuous and shall be terminated on terminal strips or terminate in a manner approved by the system's manufacturer.
14. All neutrals and ground wires in panels shall be labeled with numbered tape to indicate the circuits being served.
15. Pull conductors simultaneously where more than one is being installed in same raceway.
16. Use pulling compound or lubricant, where necessary; compound used must not deteriorate conductor or insulation.
17. Use pulling means including fish tape, cable, rope and basket weave wire/cable grips which will not damage cables or raceway.
18. Keep conductor splices to minimum.
19. Install splices and taps which possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
20. Use splice and tap connectors which are compatible with conductor material.
21. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A and B.
22. Conductors manufactured more than twelve months prior to date of delivery to site shall not be used.

#### B. WIRING CONNECTIONS AND TERMINATIONS

1. Splice only in accessible junction boxes.
2. Splices, taps and attachments of fittings and lugs shall be electrically and mechanically secure. Connectors and lugs shall be correct size for conductors joined.
3. Solid conductors, namely those sized No. 10 AWG copper, and smaller, shall be spliced by using Ideal "Wing-Nuts," 3M Co.'s "Scotchlox" or T&B "Piggy" conductors (or approved equal) in junction boxes and light fixtures, except recessed fixtures as noted below.
  - a. "Sta-Kon" or other permanent type crimp connectors shall not be used.
  - b. Contractor shall use Ideal "Wing-Nuts" for splicing recessed lighting fixture leads to branch circuit conductors.
4. Stranded conductors, namely No. 8 AWG and larger, shall be spliced by UL listed mechanical connectors plus gum tape, plus friction or plastic tape. Solderless mechanical connectors, for splices and tape provided with UL listed insulating covers, may be used instead of mechanical connectors plus tape.

5. Conductors, in all cases, shall be continuous from outlet to outlet, and no splicing shall be made except within outlet or junction boxes, troughs, and gutters.
6. Lugs for conductors No. 6 through No. 1/0 AWG shall be copper, split bolt type with spacer. Lugs for connectors No. 2/0 AWG and larger shall be copper 2-bolt type with spacer. Lugs shall be as manufactured by AMP, Inc. (or approved equal).
7. Taping of joints shall be made using special oil resistant vinyl plastic tape; UL listed, rated 105 degrees C, Scotch Electrical Tape No. 33+ or reviewed equal.
8. Splices in grounding conductors No. 8 AWG and larger shall be by means of exothermic welding and termination shall be by means of approved grounding connectors. Soldering shall not be used.
9. Thoroughly clean wires before installing lugs and connectors.
10. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
11. Terminate spare conductors with electrical tape.

C. FIELD QUALITY CONTROL

1. Prior to energization, test wires and cables for electrical continuity and for short circuits. Verify proper phasing connections.
2. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

D. WIRE AND CABLE INSTALLATION SCHEDULE

1. Exposed Interior Locations: Building wire in raceway.
2. Above Accessible Ceilings: Building wire in raceway.
3. Exterior Locations: Building wire in raceway.
4. Underground Locations: Building wire in raceway.

END OF SECTION 16120

**SECTION 16130**  
**RACEWAYS AND BOXES**

1.1 GENERAL

A. SUMMARY

1. Extent of raceway, boxes and associated fittings work is indicated by the Drawings and Schedules.
2. Types of raceways specified in this section include the following:
  - a. Liquid-tight flexible metal conduit.
  - b. Rigid steel conduit (RSC).
  - c. Rigid nonmetallic conduit.
3. This section specifies the following raceways:
  - a. Raceways installed within buildings.
  - b. Raceways installed in Earth beneath asphalt.
4. Types of electrical boxes and fittings specified in this section include the following.
  - a. Outlet boxes.
  - b. Junction boxes.
  - c. Pull boxes.
  - d. Bushings.
  - e. Locknuts.
  - f. Knockout closures.

B. SUBMITTALS

1. Product Data: For surface raceways, wireways and fittings, hinged-cover enclosures, and cabinets.

C. QUALITY ASSURANCE

1. Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes required.
2. Manufacturers: Firms regularly engaged in manufacture of electrical boxes and fittings of types and sizes required.

D. CODES AND STANDARDS:

1. NEMA Compliance: Comply with applicable requirements of NEMA Standards Publications pertaining to raceways.
2. UL Compliance and Labeling: Comply with applicable requirements of UL safety standards pertaining to electrical raceway systems. Provide raceway products and components which have been UL listed and/or labeled.
  - a. UL No. 1: Flexible Metal Conduit
  - b. UL No. 6: Rigid Steel Conduit, Zinc Coated
  - c. UL No. 6: Rigid Steel Conduit, Enameled

3. NEC Compliance: Comply with NEC as applicable to construction and installation of raceway systems, electrical wiring boxes and fittings.
4. UL Compliance: Comply with applicable requirements of UL 50, UL 514-Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes and fittings which are UL listed and/or labeled.
5. NEMA Compliance: Comply with applicable requirements of NEMA Stds/Pub No.'s OS1, OS2 and Pub 250 pertaining to outlet and device boxes, covers and box supports.
6. ANSI Publications:
  - a. C80.1 Rigid Steel Conduit, Zinc Coated
  - b. C80.2 Rigid Steel Conduit, Enameled

## 1.2 PRODUCTS

### A. CONDUIT

1. General: Provide conduit and fittings of types, sizes and weights for each service indicated. Where types and grades are not indicated, provide proper selection determined by Installer to fulfill wiring requirements, and comply with applicable portions of NEC for raceways.
2. Electrical Plastic Conduit (PVC):
  - a. Extra Heavy Wall Conduit: Schedule 80, 90 degrees C, constructed of polyvinyl chloride and conforming to NEMA TC-2, for direct burial, or concrete encased use, UL listed and in conformity with NEC Article 347.
  - b. All vertical ells shall be heavy wall rigid steel conduit.
3. PVC Conduit Fittings: NEMA TC-3, mate and match to conduit or tubing type and material.
4. Rigid Steel Conduit (RSC): Low carbon malleable iron, cadmium plated or hot-dipped galvanized inside and outside, with threaded ends, minimum size 3/4 inch. Threaded Fittings - alloy steel, galvanized.
5. Liquidtight Flexible Metal Conduit: Provide liquid-tight flexible metal conduit; construct of single strip, flexible, continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coated with liquid-tight jacket of flexible polyvinyl chloride (PVC), 3/4-inch minimum size.
  - a. Manufacturers (or approved equal):
    - 1) Sealtite Type "UA" Anaconda, Liqueflex Type "LA"
    - 2) Electri-Flex Co., International Metal Hose Co.
    - 3) Universal Metal Hose Company "Sealflex-U".
  - b. Fittings shall be Series "6000" as manufactured by (or approved equal):
    - 1) Thomas & Betts
    - 2) Crouse-Hinds
    - 3) Electri-Flex.
  - c. Where an external ground is required, fittings shall be Series "5200GR" or "5300GR."
  - d. Special care shall be taken to be sure that conduit bending radius limitations are not exceeded.
6. Expansion/Deflection Fittings: Watertight Type "XC" or Type "DX" with integral bonding jumper for rigid metal conduit permitting movement up to 3/4 inch in any

direction and angular deflection up to 30 degrees from normal in all directions as manufactured by (or approved equal):

- a. Crouse-Hinds.
  - b. O-Z/Gedney.
  - c. Appleton.
7. Sealing Fittings or Bushings: Series "EYS", "EZD" or "EYS" (as applicable) as manufactured by (or approved equal):
    - a. Crouse-Hinds.
    - b. Pyle National.
    - c. Appleton.
  8. Thruwall Sealing Fittings: Type "WKS" as manufactured by (or approved equal):
    - a. O-Z/Gedney.
    - b. Appleton.
    - c. Crouse-Hinds.
  9. Fire-Seal Fittings: Type "CFSI" as manufactured by (or approved equal):
    - a. O-Z/Gedney.
    - b. Appleton.
    - c. Crouse-Hinds.
  10. Conduit Bushings:
    - a. Insulated: Type "B" or "SBT" (as applicable) as manufactured by (or approved equal):
      - 1) O-Z/Gedney.
      - 2) Steel City.
      - 3) Myers.
    - b. Grounding: Type "BLG" as manufactured by (or approved equal):
      - 1) O-Z/Gedney.
      - 2) Thomas & Betts.
      - 3) Myers.
  11. Conduit Locknuts:
    - a. Case-hardened locknuts shall be equal to Series No. 140 by (or approved equal):
      - 1) Thomas & Betts.
      - 2) Midwest Electric.
      - 3) O-Z/Gedney.

#### B. MISCELLANEOUS MATERIAL AND FITTINGS

1. Pulling in Wire: Provide 5/32 inch polyethylene rope.
2. Thread lubricant/sealant shall be Type "STL" as manufactured by (or approved equal):
  - a. Crouse-Hinds.
  - b. Greenlee Tool.
  - c. Ideal Industries.
3. When required on joints for heat producing elements (such as lighting fixtures), thread lubricant shall be Type "HTL" as manufactured by (or approved equal):
  - a. Crouse-Hinds.
  - b. Ideal Industries.
  - c. 3M Company.

4. Nest Back Spacers: Type "NG" by (or approved equal):
  - a. O-Z/Gedney.
  - b. Appleton.
  - c. Raco.
5. Conduit Bodies:
  - a. Provide galvanized cast-metal conduit bodies of types, shapes and sizes as required to fulfill job requirements and NEC requirements.
  - b. Construct conduit bodies with threaded-conduit-entrance ends, removable covers, either cast or of galvanized steel, and corrosion-resistant screws.
  - c. Manufacturers: Subject to compliance with requirements, provide conduit bodies of one of the following (or approved equal):
    - 1) Appleton Electric; Div. of Emerson Electric Co.
    - 2) Crouse-Hinds Co.
    - 3) Killark Electric Mfg. Co.

#### C. BOXES AND FITTINGS

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
2. Interior Outlet Boxes (or approved equal):
  - a. Appleton Electric
  - b. Emerson Electric Co.
  - c. General Signal Co.
  - d. Harvey Hubbell Inc.
  - e. Midland-Ross Corp.
  - f. O-Z/Gedney
  - g. RACO Div.
  - h. Thomas & Betts Co.
3. Junction and Pull Boxes (or approved equal):
  - a. Appleton Electric
  - b. Arrow-Hart Div.
  - c. Emerson Electric Co.
  - d. General Signal Co.
  - e. O-Z/Gedney Co.
  - f. Spring City Electrical Mfg. Co.
4. Bushings, Lockout Closures and Locknuts (or approved equal):
  - a. AMP, Inc.
  - b. General Signal Co.
  - c. Harvey Hubbell Inc.
  - d. Midland-Ross Corp.
  - e. O-Z/Gedney Co.
  - f. RACO Div.
  - g. Thomas & Betts Co., Inc.

#### D. FABRICATED MATERIALS

1. Outlet Boxes: Provide galvanized coated flat rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations.

- a. Construct outlet boxes with mounting holes, and with cable and conduit-size knockout openings in bottom and sides.
  - b. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment grounding.
2. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Contractor's code-compliance option.
3. Device Boxes: Provide galvanized coated flat rolled sheet-steel non-gangable device boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations.
  - a. Construct device boxes for flush mounting with mounting holes, and with cable-size knockout openings in bottom and ends, and with threaded screw holes in end plates for fastening devices.
  - b. Provide cable clamps and corrosion-resistant screws for fastening cable clamps, and for equipment type grounding.
  - c. Where multi-device boxes are required, provide gangable boxes where more than one device is mounted together.
4. Device Box Accessories: Provide device box accessories as required for each installation, including mounting brackets, device box extensions, switch box supports, plaster ears, and plaster board expandable grip fasteners, which are compatible with device boxes being utilized to fulfill installation requirements for individual wiring situations. Choice of accessories is Contractor's code-compliance option.
5. Junction and Pull Boxes: Provide galvanized code-gage sheet steel junction and pull boxes, no knockouts, UL listed, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers.
  - a. Boxes larger than 12" in any dimension shall be provided with hinged cover.
  - b. Provide steel barriers in boxes with feeder circuits of different voltages.
6. Bushings, Knockout Closures and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit insulated bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

### 1.3 EXECUTION

- A. All installation shall comply with the NEC and OSHA.

### 1.4 EXAMINATION

- A. Examine areas and conditions under which raceways are to be installed, and substrate which will support raceways.

- B. Notify Contracting officer's representative in writing of conditions detrimental to proper completion of the work.
- C. Do not proceed with work until unsatisfactory conditions have been corrected.

#### 1.5 INSTALLATION OF CONDUITS

- A. Install conduit concealed unless indicated otherwise on the Drawings. Maintain minimum distance of six (6") inches from parallel runs of flues, steam or hot water pipes.
- B. Use liquid-tight flexible metal conduit for connections to motors, transformers and other equipment subject to vibration and in areas subject to moisture.
- C. Use flexible metal conduit for connections to recessed and/or semi-recessed lighting fixtures.
- D. Space groups of conduits uniformly. For bends and offsets, use an approved hickey or bending machine.
- E. Cut all conduit with hacksaw or approved cutting machine and ream after threading to remove all burrs.
- F. Fasten conduit securely to outlets, junctions and pullboxes to ensure firm electrical contact.
  - 1. Join conduit with approved couplings.
  - 2. No running threads will be allowed.
  - 3. Install insulated bushings and double locknuts on threaded conduits entering or leaving sheet metal outlet, junction, or pull boxes, and cabinets.
  - 4. Install grounding bushings on all conduits entering an enclosure such as a motor control center from below where the conduit is not attached to the enclosure.
  - 5. Bond all bushings to ground bus using conductor the same size as the equipment grounding conductor in the conduit.
  - 6. Install compression type connectors with insulated throats on electrical metallic tubing entering or leaving sheet metal outlet, junction or pull boxes and cabinets.
- G. Avoid condensation pockets in installations. Keep conduit, fittings, and boxes free from foreign matter, before, during and after installation.
- H. Not more than one (1) exposed conduit shall be run down to an exposed wall switch or outlet box.
- I. Use expansion/deflection fittings where rigid metal conduits pass from existing building structures to additions on new foundations, every 200 feet linear run maximum, and where otherwise indicated on the Drawings.
  - 1. Use thruwall sealing fittings where conduits enter buildings or vaults below finished grade.

2. Do not use aluminum conduit on this project.
3. Support runs of metallic conduit at least every eight (8') feet.
4. Install runs of conduit parallel or perpendicular to walls, structural members or intersections of vertical planes and ceilings. Provide right angle turns consisting of fittings or symmetrical bends.
5. Support conduits within one (1') foot of all changes in direction. Supports shall include wall brackets, trapeze hangers, strap hangers or pipe straps secured to hollow masonry with toggle bolts, to brick and concrete with expansion bolts, to metal surfaces with machine screws and to wood with wood screws.
6. The use of wooden plugs (inserted in masonry), tie wire or nails as fastening media is prohibited.
7. Support conduit risers exposed in wire shafts at each floor level with approved U-clamp hangers.
8. Install empty conduit for future use as indicated on the Drawings. Conduit shall be complete with rope, junction and outlet boxes.
9. Conduit shall not be supported from metal roof deck.
10. Provide pitchpocket where conduit penetrates roof.
11. Conduit shall not penetrate concrete bases designed for vibration isolation.
12. Apply thread lubricant/sealant to joints of all conduit buried in earth or concrete encased.
13. Install fire-seal fittings or UL classified foam sealant where conduits penetrate concrete floor slabs or masonry walls required to be fire rated.
14. Use nest back spacers in conjunction with conduit spacers or clamp backs when additional spacing away from mounting surface is required.
15. All conduits shall be installed as high as possible in the ceiling cavity. Coordinate all conduit installation with ductwork.
16. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.
17. Install miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split coupling, and plugs that have been specifically designed and manufactured for their particular application.
18. Use roughing-in dimensions of electrically operated unit furnished by supplier.
19. Set conduit and boxes for connection to units only after receiving review of dimensions and after checking location with other trades.
20. Test conduits required to be installed, but left empty, with ball mandrel.
21. Clear any conduit which rejects ball mandrel.
22. Pay costs involved for restoration of conduit and surrounding surfaces to original condition.
23. Cut conduits straight, properly ream, and cut threads for heavy wall conduit deep and clean.

24. Field-bend conduit with benders designed for purpose so as not to distort or vary internal diameter.
25. Size conduits to meet NEC, except no conduit smaller than ¾ inch shall be installed.
26. Fasten conduit terminations in sheet metal enclosures by 2 locknuts, and terminate with insulated bushing. Install locknuts inside and outside of enclosure.
27. Conduits are not to cross pipe shafts or ventilating duct openings.
28. Support riser conduit at each floor level with clamp hangers.
29. Use of running threads at conduit joints and terminations is prohibited. Where required, use 3-piece union or split coupling.
30. Complete installation of electrical raceways before starting installation of cables/wires within raceways.
31. Support exposed conduit by use of hangers, clamps or clips.
32. Support conduit within 3'-0" of each outlet box, junction box, cabinet or fitting and on each side of bends and on spacing not to exceed following: Rigid metal conduits up to 1": 6'-0"; 1-1/4" and over: 8'-0"; EMT up to 1": 5'-0"; 1-1/4" and over: 8'-0".
33. Arrange conduit supports to prevent distortion of alignment by wire pulling operations.
34. Fasten conduit using galvanized straps, caddy clamps, lay-in adjustable hangers, clevis hangers, or bolted split stamped galvanized hangers.
35. Requirements for exposed conduits also apply to conduits installed in space above hung ceilings.
36. Exposed Conduits:
  - a. Install conduits as not to damage or run through structural members. Avoid horizontal or cross runs in building partitions or side walls.
  - b. Install exposed conduits and extensions from concealed conduit systems neatly, parallel with, or at right angles to walls of building.
  - c. Install exposed conduit work as not to interfere with ceiling inserts, lights or ventilation ducts or outlets.
  - d. Run conduits for outlets on waterproof walls exposed. Set anchors for supporting conduit on waterproof wall in waterproof cement.
  - e. Requirements for exposed conduit also apply to conduits installed in space above hung ceilings.
37. Conduit Fittings:
  - a. Construct locknuts for securing conduit to metal enclosure with sharp edge for digging into metal, and ridged outside circumference for proper fastening.
  - b. Install insulated type bushings for terminating conduits. Bushings are to have flared bottom and ribbed sides. Upper edge to have phenolic insulating ring molded into bushing.
  - c. Miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split coupling, and plugs to be specifically designed for their particular application.

- d. Install expansion fittings in all raceways wherever structural expansion joints are crossed.
- 38. Make changes in direction of raceway run with proper fittings, supplied by raceway manufacturer.
- 39. Properly support and anchor raceways for their entire length by structural materials. Raceways are not to span any space unsupported.
- 40. Use boxes as supplied by raceway manufacturer wherever junction, pull or devices boxes are required. Standard electrical "handy" boxes, etc. shall not be permitted for use with surface raceway installations.
- 41. Arrange conduit to maintain headroom and present a neat appearance.
- 42. Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.
- 43. Group conduits in parallel runs where practical and use conduit rack constructed of steel channel with conduit straps or clamps. Provide space for 25% additional conduit.
- 44. Do not fasten and/or hang conduit with wire or perforated pipe straps. Remove all wire used for temporary conduit support during construction, before conductors are pulled.
- 45. Bring conduit to the shoulder of fittings and couplings and fasten securely. Raceways shall be cut to proper length so ends fit accurately in outlets.
- 46. Use conduit hubs for fastening conduit to cast boxes, and for fastening conduit to sheet metal boxes in damp or wet locations.
- 47. Install no more than the equivalent of three (3) 90 degree bends between boxes.
- 48. Use conduit bodies to make sharp changes in direction, as around beams.
- 49. Use hydraulic one-shot conduit bender for bends in conduit smaller than 2" size, or factory elbows for bends in conduit 2" and larger. Bends in metallic conduit shall be made while "cold."
- 50. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.
- 51. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.
- 52. Where conduit penetrates fire rated walls, provide pipe sleeve two sizes larger than conduit; seal opening around conduit with UL listed foamed silicone elastomer compound.
- 53. Route conduit through roof openings for piping and ductwork where possible; otherwise, route through roof jack with pitch pocket.
- 54. Combining of circuits other than as indicated on the Drawings shall not be permitted.
- 55. Bolts, clamps, screws and expansion bolts shall be used in securing conduit, equipment, etc. Holes for lead shields shall be drilled in solid brick or concrete and must be neatly cemented after bolts are in place.

J. INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

1. General: Install electrical boxes and fittings as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, OSHA, and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.
2. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.
3. Provide weathertight outlets for interior and exterior locations exposed to weather or moisture.
4. Provide knockout closures to cap unused knockout holes where blanks have been removed.
5. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.
6. Avoid installing boxes back-to-back in walls. Where receptacles are shown back-to-back in walls, they shall be mounted in separate boxes, a minimum of 6" apart (24" in acoustic rated walls) and connected together using flex with ground wire. Flex will not be acceptable for system grounding. The flex shall have a loop for limiting sound transmissions. Outlet boxes shall be equipped with plaster rings of appropriate depth to finish flush with finished wall. Outlets in exposed masonry walls shall be equipped with extra deep square corner tile rings so that boxes may be installed in brick walls or in the core of the block.
7. Aluminum products shall not be installed.
8. Position recessed outlet boxes accurately to allow for surface finish thickness.
9. Do not use round boxes unless noted otherwise on the Drawings.
10. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry. Boxes shall be supported independently of conduit.
11. Provide electrical connections for installed boxes.
12. Electrical box locations indicated on the Drawings are approximate unless dimensioned. Verify location of outlets prior to rough-in. Outlet may be relocated by the Contracting Officer or authorized representative at no additional cost.
13. Locate and install to maintain headroom and to present a neat appearance.
14. Use multiple gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.
15. Install boxes in walls without damaging wall insulation.
16. Position outlets to locate luminaries as indicated on the Drawings.
17. Align wall mounted outlet boxes for switches, thermostats, and similar devices.
18. Subsequent to installation of boxes, protect boxes from construction debris and damage.

19. Support all outlet boxes as required by the NEC. Suspended outlet boxes shall be independently supported from raceway by means of 1/4" all thread rod to structure.
20. All outlet boxes or plaster rings shall finish flush with finished wall or ceiling. Outlets which do not finish flush (recessed) shall be equipped with copper tube stand-off nipples of proper length to hold wiring device securely in place. Wiring device shall be secure and shall not push in or rock.

K. GROUNDING

1. Upon completion of installation work, properly ground electrical boxes and demonstrate compliance with requirements of Section 16060 – GROUNDING AND BONDING.

L. JUNCTION AND OUTLET BOX IDENTIFICATION:

1. Identify each junction and outlet box cover with color and the type system that is within the box. Sample identifications are as follows:
2. Fire Alarm (Red): Name "FIRE ALARM".
3. The written labels above shall be neatly and legibly marked on the outside of the box covers using a permanent black ink marker.

END OF SECTION 16130

## SECTION 16721

### FIRE DETECTION, ALARM AND RADIO TYPE REPORTING SYSTEM

#### 1.1 GENERAL

- A. This specification outlines requirements for modifications of the existing fire alarm monitoring and control equipment for Building 5015 at Seymour Johnson Air Force Base at Goldsboro, North Carolina.

#### B. REFERENCES

1. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. All publications shall be referred to in their latest edition, including any revisions thereof.

- a. American National Standards Institute(ANSI)

ANSI C62.41	Recommended Practice for Surge Voltage in Low-Voltage AC Power Circuits
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- b. National Fire Protection Association (NFPA)

NFPA 70	National Electrical Code
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NFPA 72	National Fire Alarm Code
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NFPA 78	Lightning Protection Code
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NFPA 90A	Installation of Air Conditioning and Ventilation Systems
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- c. Underwriters Laboratories, Inc. (UL)

UL Directory	Fire Protection Equipment Directory
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UL 06	Rigid Metal Conduit
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UL 38	Manually Actuated Signaling Boxes for Use with Fire-Protective Signaling Systems
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UL 268	Smoke Detectors for Fire Protective Signaling Systems
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UL 268A	Smoke Detectors for Duct Application
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UL 464	Audible Signal Appliances
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UL 521	Heat Detectors for Fire Protective Signaling Systems
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UL 797	Electrical Metallic Tubing
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2. All work and equipment shall comply with applicable OSHA requirements and with applicable FCC requirements.

#### C. GENERAL REQUIREMENTS

1. Products: The Contractor shall provide additional initiating devices and alarm indicating appliances to an existing low voltage, automatic integrated transceiver/fire alarm control panel.
  - a. Provide new 4002, 4 circuit zone card for existing Simplex Model 4100 fire alarm panel.
  - b. Connect new indicating and notification devices as detailed in this specification, and as shown on the Drawings.
2. Any additional modules required are to be purchased and installed by certified personnel.
3. Verification of Dimensions: The contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer or authorized representative of any discrepancy before performing the work.
4. Compliance: The fire detection and internal alarm system shall be configured in accordance with NFPA 72. The equipment furnished shall be compatible and be UL listed or FM approved or approved or listed by a nationally recognized testing laboratory in accordance with the applicable NFPA standards.
5. Manufacturer's Services: Services of a manufacturer's representative who is certified in the installation, maintenance, adjustment, operation and repair, of the equipment specified shall be provided. The representative shall supervise the installation, adjustment, programming, testing and certification of the equipment.
6. Delivery and Storage: All equipment delivered and placed in storage shall be protected from the weather, humidity and temperature variations, dirt, dust, and other contaminants.
7. Programming: Contractor is required to fully program the transceiver and the D-500 to communicate by zone and remote test.

#### D. SYSTEM DESIGN

1. Operation: Existing system is a complete, supervised fire alarm system and additional devices shall be incorporated to maintain system integrity. The system is activated into the alarm mode by actuation of any alarm initiating device. The system shall remain in the alarm mode until any initiating device is reset and the fire alarm control panel is manually reset and restored to normal. Electrical supervision shall match existing and be in accordance with NFPA 72. All circuits shall be capable of operating under a single ground or open condition, as specified in NFPA 72. All textual, audible and visual devices and systems shall comply with NFPA 72.
2. Operational Features. The existing system shall be modified to accommodate additional pull stations and alarm indicating devices as shown on drawing:

- a. Alarm initiating (zone) circuits for connection of detection devices shall match class of existing alarm initiating (zone) circuits.
- b. Auxiliary zone circuits for connection of non-powered alarm initiating devices such as tamper switches, heat detectors or manual pull stations.
- c. Alarm indicating (bell) circuits for connection of audible and visual alarm evacuation signaling devices shall match class of existing alarm indicating circuits.
- d. Zone programming capability which allows entry of a zone identification number, thirteen character description and type. Each zone is programmed for standard, supervisory, verification, positive alarm sequence, or water-flow warm operation; the auxiliary zones may also be programmed for tamper or for publicly accessible manual pull station.
- e. Zones for alarm initiating circuits shall be arranged as indicated on the contract drawings.
- f. Alarm functions. An alarm condition on a circuit shall automatically initiate the following functions:
  - 1) Transmission of a signal (by zone and general alarm/general trouble) over the station fire reporting system.
  - 2) Visual indication of the alarmed zone on the fire alarm control panel annunciator..
  - 3) Continuous sounding of alarm indicating devices throughout the building.
  - 4) Operation of the smoke control system.
  - 5) Deactivation of the air handling, exhaust fans units throughout the building.

#### E. SUBMITTALS

1. Installer Qualification. Installer must have five years experience in the installation of fire alarm systems and possess a minimum LEVEL II certificate from the NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET) in the sub-field FIRE PROTECTION ENGINEERING TECHNOLOGY (FIRE ALARM SYSTEMS). No fire alarm work is to be done with non-certified personnel (ie. electrician, helper, etc.)
2. Shop Drawings. Shop drawings shall be submitted and shall consist of a complete set of equipment and materials, including manufacturer's descriptive and technical literature; performance charts and curves; catalog cuts; and installation instructions. Detail drawings shall also contain complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.
3. Test Reports. Upon completion and testing of the installed system, test reports shall be submitted in booklet form showing all field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls.
4. Spare Parts Data. After approval of the shop drawings the contractor shall furnish spare parts data for each different item of materials and equipment specified. The data shall include a complete list of parts and supplied, with current unit

prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 3 years of service.

5. **As Built Drawings. PRIOR TO PERFORMANCE AND ACCEPTANCE TESTING.** The contractor shall submit two legible copies of all fire alarm drawings showing the "as-built" system. The detail drawings of the fire detection system shall be signed by a Fire Protection Engineer. The drawings shall consist of a complete list of equipment and material, including manufacturer's descriptive and technical literature and catalog cuts. The drawings shall also contain complete wiring and schematic diagrams for the equipment furnished, equipment layout, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. The detailed point-to-point wiring diagram showing all points of connection shall include connections between system devices, appliances, control panels, supervised devices, and all equipment that is activated by the control panel.
6. **Certificates of Completion. PRIOR TO PERFORMANCE AND ACCEPTANCE TESTING.** a Certificate of Completion per NFPA 72 shall be given to the Contracting Officer or authorized representative. "NOTE" The individual signing the certificate is warranting that the fire alarm system has been installed per NFP, NEC, UL and Air Force specifications and codes.

#### F. OVER VOLTAGE AND SURGE PROTECTION

1. **Power Line Surge Protection.** All equipment connected to alternating current circuits shall be protected from power line surges. Equipment shall meet requirements of ANSI C62.41. Surge protector shall be a Delta LA 301 or equal.

#### G. DELIVERY AND STORAGE

1. All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust, any other contaminants.

### 1.2 PRODUCTS

#### A. Manual Fire Alarm Stations:

1. Manual fire alarm stations shall conform to the applicable requirements of the UL 38. Manual stations shall be connected into alarm initiating circuits. Stations shall be single action type. Stations shall be finished in red, with raised letter operating instructions of contrasting color. Stations requiring the breaking of glass or plastic panels for operation are not acceptable. Stations employing glass rods are not acceptable. The use of a key or wrench shall be required to reset the station. Gravity or mercury switches are not acceptable. Switches and contacts shall be rated for the voltage and current upon which they shall operate. Stations shall have a separate screw terminal for each conductor. Where boxes must be surface mounted, boxes shall be painted the same color as the fire alarm manual stations. All manual pull stations located in the public areas shall have clear shield protective tamper cover placed over them.

#### B. NOTIFICATION APPLIANCES

1. Audible appliances shall be heavy duty and conform to the applicable requirements of UL 464. Devices shall be connected into alarm indicating circuits. All devices shall have separate screw terminals for each conductor.
2. Combination Audible/Visual Notification Appliances. Combination audible/visual appliances shall be factory assembled. Units shall be suitable for use in an electrically supervised circuit and shall have a sound output rating of at least 85 dBA at 10 feet. Visual indication shall be accomplished by high intensity optic lens and flash tubes.

C. FIRE DETECTION AND ALARM SYSTEM PERIPHERAL EQUIPMENT

1. Conduit shall comply with UL 06 and UL 797.
2. Wiring. All wiring shall be copper. Wiring for strobe light circuits shall be No. 14 AWG minimum. Wiring for 120 v AC power shall be No. 12 AWG minimum. Wiring for power limited circuits shall be No. 16 AWG minimum/Power wiring and control wiring shall be isolated. All wiring shall conform to NFPA 70. All conductors shall be color coded. Wiring code color shall remain uniform throughout the circuit. Pigtail or T-tap connections are unacceptable.

1.3 EXECUTION

A. INSTALLATION

1. All work shall be installed as shown and in accordance with the manufacturer's diagrams and recommendations, unless otherwise specified.
2. Wiring. Wiring for systems shall be installed in 1/2 inch minimum diameter conduit; however the wiring for the fire alarm system shall not be installed in conduits, junction boxes with conductors of lighting and power systems. No more than one conductor shall be installed under any screw terminal. All circuits conductors entered or leaving any mounting box, outlet box enclosure or cabinet shall be connected to terminals with each terminal marked in accordance with the wiring diagram for identification. Connections shall be made with either crimp-on terminal spade lugs or with approved pressure type terminal blocks. The use of wire nut type connectors are prohibited in the system. All wiring within any control equipment shall be readily accessible without removing any component parts. The fire alarm equipment manufacturer's representative shall be present for the connection of wiring to the control panel.
3. Painting. All junction boxes shall be painted red.
4. Notification Appliances. Devices shall be mounted 6 feet 8 inches above the finished floor elevation, or 6 inches below finished ceiling, if limited by ceiling height.
5. Grounding. Grounding shall be provided to building ground.
6. Manual Pull Stations shall be installed at approximately 4 feet (center) above finished floor elevation unless otherwise indicated.

B. TESTING

1. The contractor shall notify the Contracting Officer or authorized representative 30 days before the performance and acceptance tests are to be conducted. The

Contractor shall provide battery calculations for the fire alarm system to the Contracting Officer or authorized representative 30 days prior to the acceptance test. The test shall be performed in the presence of the Contracting Officer or authorized representative under the supervision of the fire alarm system manufacturer's qualified representative. The contractor shall furnish all instruments, equipment and personnel required for the tests.

2. Preliminary Tests. Upon completion of the installation, the system shall be subjected to functional and operational performance tests including tests of each installed initiating and notification appliance. Tests shall include the meggering of all system conductors to determine that the system is free from grounded, shorted and open circuits. The megger test shall be conducted prior to the installation of fire alarm equipment. Smoke detector bases shall be equipped with jumpers for the megger test. If deficiencies are found, corrections shall be made and the system shall be retested to assure that is functional.
3. Acceptance Test. The testing shall be in accordance with NFPA 72 and shall verify that all previous deficiencies have been corrected. The test shall include the following functions as applicable to the circuits modified or added:
  - a. Test of each function of the control panel.
  - b. Test of each circuit in both trouble and normal modes.
  - c. Test of alarm initiating devices in both normal and trouble conditions.
  - d. Test of each control circuit and device.
  - e. Test of each alarm notification appliance.
  - f. Test of the battery charger and batteries.
  - g. Complete operational test under emergency power supply.
  - h. Visual inspection of all wiring connections.
  - i. Opening the circuit at each alarm initiating and indicating device to test the wiring supervisory feature.
  - j. Test of the as-built drawings to insure that they are correct.

END OF SECTION 16721

SCHEDULE OF MATERIAL SUBMITTALS														PROJECT NUMBER VKAG 98-1124		PROJECT TITLE REPAIR FIRE SUPPRESSION, BLDG. 5015		SOLICITATION/CONTRACT NUMBER				
TO BE COMPLETED BY PROJECT ENGINEER														TO BE COMPLETED BY CONTRACT ADMINISTRATOR								
LINE NUMBER	ITEM OR DESCRIPTION OF ITEM, CONTRACT REFERENCE, TYPE OF SUBMITTAL	NUMBER OF COPIES REQUIRED												DATE RECEIVED IN CONTRACTING	DATE TO CIVIL ENGINEERING	RETURN SUSPENSE	SUBMITTAL NUMBERS	DATE CONTRACTOR NOTIFIED		CONTRACTOR RESUBMITTAL	FINAL APPROVAL	REMARKS
		CERTIFICATION OF COMPLIANCE	SHOP DRAWINGS	SAMPLES	COLOR SELECTION	MANUFACTURERS RECOMMENDATIONS	MANUFACTURERS WARRANTY	CATALOG DATA	OPERATING INSTRUCTIONS	OTHER	SUBMITTAL CODE	REQUIRED SUBMISSION DATE	APPROVED					DISAPPROVED				
1	02510 PARA 1.1.E.1 NRS GATE VALVE							3				A										
2	02510 PARA 1.1.E.1 OS&Y GATE VALVE							3				A										
3	02510 PARA 1.1.E.1 TAPPING SLEEVE							3				A										
4	02510 PARA 1.1.E.1 DUCTILE IRON PIPE							3				A										
5	02510 PARA 1.1.E.1 DUCTILE IRON PIPE FITTINGS							3				A										
6	02510 PARA 1.1.E.1 POST INDICATOR							3				A										
7	02510 PARA 1.1.E.1 BACK FLOW PREVENTER							3				A										
8	02510 PARA 1.1.E.1 PREFAB CONCRETE VAULT							3				A										
9	02510 PARA 1.1.E.1 SITE PLAN		3									A										
10	02510 PARA 1.1.E.3 CONTRACTOR'S MAT. & TEST CERT. FOR UNDERGRD PIPING	3										B										
11	02510 PARA 1.1.E.3 PUR. & DISINF. REPORTS	3										B										

**SUBMITTAL CODES: A: 30 DAYS AFTER NTP    B: DURING CONSTRUCTION**

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		CERTIFICATION OF COMPLIANCE	SHOP DRAWINGS	SAMPLES	COLOR SELECTION	MANUFACTURER'S RECOMMENDATIONS	MANUFACTURER'S WARRANTY	CATALOG DATA	OPERATING INSTRUCTIONS	OTHER	SUBMITTAL CODE	REQUIRED SUBMISSION DATE					APPROVED	DISAPPROVED			
45	13916 PARA 1.1.D.4 HYDROSTATIC TESTS	3									B										
46	13921 PARA 1.2A FIRE PUMP							3			A										
47	13921 PARA 1.2A PRESSURE MAINT. PUMP							3			A										
48	13921 PARA 1.2B WIRING DIAGRAM		3								A										
49	13921 PARA 1.2A FIRE PUMP CONTROLLER						3				A										
50	13921 PARA 1.2A PM PUMP CONTROLLER						3				A										
51	13921 PARA 1.2.C FIRE PUMP							3			A										
52	13921 PARA 1.2.C FIRE PUMP CONTROLLER							3			A										
53	13921 PARA 1.2.D FIRE PUMP						3				A										
54	13921 PARA 1.2.D FIRE PUMP CONTROLLER						3				A										
55	16120 PARA 1.1.B.1 CONDUCTORS AND CABLES							3			A										

**SUBMITTAL CODES: A: 30 DAYS AFTER NTP    B: DURING CONSTRUCTION**

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